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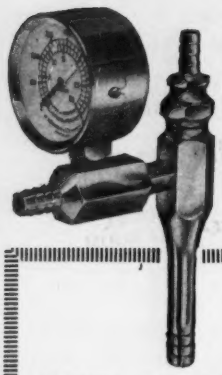

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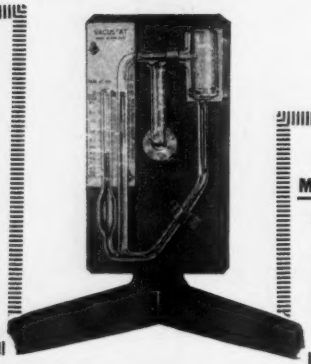

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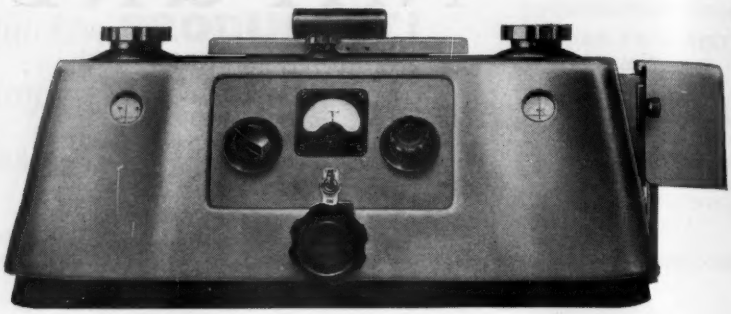

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EDUCATIONAL ADVANCEMENT AND THE UNDER-DEVELOPED COUNTRIES

SOME decisions taken at the Commonwealth Trade and Economic Conference which met in Montreal last September have already been discussed in these columns (see *Nature*, December 20, p. 1693). Their full significance is probably only to be appreciated in the light of the very large gap that exists between the standard of life in Asia and the standard of life in North America or Europe. The existence of that gap is, of course, well known, and was brought out by Prof. P. M. S. Blackett in his presidential address in Dublin to the British Association; but, in pointing that out at Montreal, it was emphasized that the essential problem in Commonwealth relations is the widely different rate of economic progress between the highly industrialized and the under-developed countries, and Sir David Eccles reminded the House of Commons on November 4 that this gap is growing wider every year. That is less well known and is extremely dangerous, and it is this sense of falling further behind that disturbs the poorer nations in the free world and may induce policies that threaten their stability.

At Montreal, said Sir David, the Conference was asked what would happen if the living standards in China rose appreciably faster than the living standards in India and Pakistan. This is one of the most serious questions in the world to-day, and the Commonwealth Conference was a success because it accepted the challenge of the widening gap and devoted its best endeavours to considering how the under-developed countries could be further helped to increase their rate of progress. Even if we and other creditor countries in the free world give the under-developed countries all the aid we can, it is unlikely to suffice to finance a tolerable rate of development. This is why they need to increase their export earnings, and the Haberler report has shown that such exports must include an increasing proportion of manufactured goods.

Unless, Sir David continued, the United States and Europe buy more goods from the under-developed countries, it is hard to see how these countries can respect and adhere to the Western economic system. It is here that the real Soviet challenge lies, for once countries in Asia and Africa are bound to the Soviet block by strong economic ties, they are unlikely to remain neutral, far less align themselves with Western democracy. The practical measures concerted at Montreal were designed to meet this major issue, and they attest in particular the willingness of the United Kingdom to make the major contribution to Commonwealth development.

While the Conference recognized that development is vital not only to the economic expansion of the Commonwealth but also to the whole structure of relationships within the Commonwealth and to the maintenance of democratic institutions, the closing of this gap in standards of living was seen as a human and moral responsibility which members of the Commonwealth share with other countries. In particular, Sir David Eccles referred to the fact that no group of nations in the free world can either resist the Communist challenge from without or achieve balanced progress within its own ranks unless the United States plays a major and consistent part in maintaining economic activity and in opening its markets to the free world. We are forced back again on the interdependence of the free world as plainly as were Mr. Macmillan and President Eisenhower in their meeting during the previous autumn.

Mr. Nixon's remarks on this point in his speech at Guildhall, with its tribute to the "dedicated and effective work of the superb Colonial administrators" of the British Empire, were particularly welcome in this connexion, both as evidence of a growing understanding of the British contribution and for the reaffirmation of Mr. Nixon's deep concern to see that American foreign aid is maintained effectively in the countries which the U.S.S.R. is seeking to influence. Indeed, it is increasingly apparent that the relation of development to security is recognized, and that it is appreciated that trade and aid are important factors in a real defence policy. President Eisenhower, for example, coupled his request to Congress last year for 3,942 million dollars for the foreign aid programme with a reminder that any significant cut in this figure could lead to a massive increase in military spending by the United States, higher taxes and an increase in the rate of conscription, due to severe dislocation and impairment of the power of the free world, and the crumbling, under Sino–Soviet pressures, of United States strategic overseas positions, which might be forced back towards its own shores.

It is not, of course, only to the United States that the value of the aid programme to a country is many times greater than what it costs that country; but in spite of what was said by the Prime Minister at the Lord Mayor's banquet and by him and Mr. Nixon at Guildhall, it will not be too easy to convince the ordinary citizen of this close connexion, and to bring home to him how important it is that assistance to the under-developed countries should be forthcoming on an adequate scale, even at the cost of some sacrifice in the standard of living in the more advanced industrialized countries. The White Paper stressed also the importance of providing the under-developed countries with opportunities to expand their trade on a stable basis, thereby increasing their export earnings and improving their prospects of attracting external capital. Neither in the House of Lords nor in the House of Commons,

however, did the implications in the way of sacrifices demanded of the more industrialized countries receive much attention, though further reference to the gap was made in a debate in the House of Lords on December 18, notably in a speech by Lord Strang, who directed attention to the emphasis placed by Mr. Nehru on the grave political implications of the gap in his opening speech at the meeting of the International Bank and Monetary Fund at New Delhi.

In his speech in opening the debate on Commonwealth and international economic problems in the House of Commons on December 2, the Chancellor of the Exchequer, Mr. Heathcoat-Amory, dealt with the problem of development at some length and pointed out that the highly developed countries had expressed at Montreal a strong desire to expand the substantial help they were already giving to other Commonwealth countries. Some 70 per cent of new overseas investment in the Commonwealth since the War has come from Britain, but Mr. Heathcoat-Amory also pointed out that any country which wishes to encourage long-term private investment should make sure that conditions are favourable, and he also emphasized that the highly developed countries can only give such help if their own economies are maintained strong. Since the Montreal Conference the Government has announced, at the recent meeting of the Consultative Committee for the Colombo Plan, that the United Kingdom would make available a further £2 million for technical assistance.

All this stresses the vital importance of educational development on both sides, and Mr. Heathcoat-Amory characterized the decision on education, along with those on the improvement of telecommunications and the improvement of Commonwealth economic consultation, as the three imaginative decisions taken at Montreal. As in the House of Lords on November 4, the proposals for Commonwealth scholarships and fellowships and for an educational conference was warmly welcomed, and that their significance is appreciated appears from the stress laid by Mr. J. E. Ramsden on the teaching of English and the importance of getting more teachers of English. Sir David Eccles said, in reply, that this part would be much in mind at the conference, which would deal with the provision of teachers as well as the scheme for university students. Mr. Ramsden also referred to the importance of an adequate supply of English books, and particularly welcomed the emphasis laid in the report on training in the humanities as well as in science, stressing the relation of all the educational proposals to technical development and the value of a two-way traffic in scholars and students between the overseas countries of the Commonwealth and Great Britain.

Mr. M. MacPherson also stressed the importance of not limiting the conference on education to universities and students at an advanced level. Mr. Heathcoat-Amory had stated that already 10–12 per cent of the total places in universities and technical colleges in Britain are allotted to overseas students, two-thirds of whom come from the Commonwealth, and Mr. MacPherson suggested that it is important to get a general picture of educational needs and opportunities in the Commonwealth, so that the magnitude of the demand at the university and professional level can be assessed and the real priorities seen. What is implied in the allocation of 10–12 per cent of the places to overseas students should be known and appreciated. Mr. J. Johnson, for example, who maintained that the struggle between East and West would be determined not by arms or conflict, but by the standard of education, and that our biggest investment should be in educated people, thought that present standards in our overseas universities are much too high.

The decision as to which stage should receive priority is by no means simple. Even where the most pressing need is for primary education, the additional teachers needed involve a simultaneous effort at least in secondary education to provide them; nor can the country itself train them without expansion at the training college or university level. Indeed, it is in this interlocked situation that the contribution of the Inter-University Council for Higher Education in the Colonies has been so outstanding, and, quite apart from the continuing demand for places for overseas students in British universities and technical colleges as our own programme of expansion proceeds, the scarcity of scientific and technical manpower relates the needs of the overseas territories to those of Britain. Neither educational expansion nor technical assistance can be planned without regard to available resources in man-power, finance and equipment.

Here, therefore, as the report on the Montreal Conference sufficiently shows, educational advance overseas is related to the programme of expansion in Britain, just as much as are technical assistance and Colonial research, for example. It may well be that besides increasing economic aid to the under-developed countries, we need to find some new form of international organization to channel and co-ordinate all aid programmes. The Special United Nations Fund for Economic Development might have served, had the United States been willing to accept a plan that left the distribution of aid largely in the hands of the recipient countries themselves.

Nevertheless, the breakdown of that proposal only emphasizes a further dual aspect of the dependence of any such economic offensive on education. It is not simply that educational expansion, both in Britain and in other advanced countries, is required to provide the trained man-power of all kinds that technical aid and development demand, just as much as in the under-developed countries; it is the condition of their being able to utilize such assistance and to promote development schemes. On such educational development depends the formation of a body of public opinion and understanding in the advanced countries which will accept and sustain the programmes with all the sacrifices they entail and, in the under-developed countries, provide the climate of opinion and stability necessary both for continuity and to attract the necessary financial capital.

Nor is this any less true of the policies required to establish and maintain national food reserves in the under-developed countries set out in a recent report of the Food and Agriculture Organization*.

It is in this context that we should welcome the attention now being given in the United States to research in the tropics and particularly in Africa. Lord Hailsham's remarks to the Canada Club on November 18 are also worth noting. Canada, it may be recalled, announced at Montreal that it proposed to make 10 million dollars available as economic assistance to the West Indies over the next five years, to include provision of a second ship for the West Indies inter-island shipping service. Lord Hailsham suggested that, if the Commonwealth is to fulfil its purpose, relations must develop between the individual members of the Commonwealth on a scale almost comparable to their existing relations with Britain. Accordingly, the Commonwealth needs to think out afresh the nature and purposes of the association between its members, and the means by which that association can be enhanced.

Lord Hailsham referred to three urgent needs: to understand clearly the later development of the Commonwealth; to diversify and enrich inter-Commonwealth relations; and to foster, on a non-political level, the closest contact between individuals, business associations and professions. In particular, he stressed the need to share and think out afresh the vast task of investment and assistance in scientific research and technical education, if only to ensure that assistance is freed from any suspicion of political dependence. Finally, he emphasized the dependence of the Commonwealth on certain moral and spiritual values which are not exclusive but universal to mankind. These values are those in which science in particular flourishes and, if at this juncture technical assistance offers a particular challenge to the scientist and technologist in Britain, in the measure in which they seek to answer the challenge as indicated at Montreal they will be furthering and safeguarding the advance of science itself.

*Food and Agriculture Organization of the United Nations. FAO Commodity Policy Studies No. 11: National Food Reserve Policies in Underdeveloped Countries. Pp. vi+70. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1958.) 5s.; 1 dollar.

EARLY TEXTILE TECHNOLOGISTS

The Strutts and the Arkwrights, 1758–1830

A Study of the Early Factory System. By R. S. Fitton and A. P. Wadsworth. Pp. xii+361+19 plates. (Manchester: At the University Press, 1958.) 35s. net.

"WE must reason from what we know, and inventing is only looking at all sides of a thing and putting it in different points of view, and by long habit and a great store of ideas this becomes almost mechanical." So William Strutt, F.R.S., addressed his son, then a pupil at a Nonconformist academy, in 1818. Earlier he had expressed the hope that "in a few years you will be recommended for the R.S.". The son's felicity was obtained in other ways: he married the daughter of a bishop and was created Baron Belper in 1856. No apter tribute could have marked the centenary of the invention of the Derby rib machine by his grandfather, Jedediah Strutt.

Nonconformity had few families of such dynastic tenacity. Jedediah (1726–1797), son William (1756–1830) and grandson Edward (1801–1880) were all in their way remarkable. Jedediah, backed by dissenting hosiers at Derby and another at Nottingham, launched into manufacturing silk hose at Belper, Milford and Derby. By 1769, when he was forty-three years old, he was prosperous enough to become a backer himself. His protégé and partner, Richard Arkwright, had a roller-spinning machine, and two years later they built a factory at Cromford. This, as R. S. Fitton and A. P. Wadsworth remark in their closely documented and well-reasoned study, "was one of the turning points in the history of the factory system". It was the first of the cotton factory villages that were to change the landscape of the north of England during the next half-century. Arkwright prospered, too, and built Birkacre, near Chorley—the first to be put up outside Derbyshire—and Nottingham, Worksworth, Manchester, Matlock Bath and Bakewell, and in turn he financed Samuel Oldknow, who was manufacturing muslin. Though the Strutt – Arkwright partnership seems to have dissolved in 1781, the complex of a half-dozen factory colonies were all within a dozen miles of each other and the Strutt colonies soon outpaced the Arkwrights. Jedediah died sixteen years later and was buried in the Unitarian Chapel at Belper. His three sons, led by William, transformed the business and the cotton mills. The power of the Belper Mills was afforded by the turbulent Derwent, and a writer in "Rees' Cyclopædia" described them as "the most complete we have seen in their dams and waterworks". By 1820 fourteen acres of water had been added to the Derwent reaches just above Belper Bridge.

The water-driven machinery never stopped except for the dinner break. In these integrated factory colonies breakfast, dinner and tea were provided and, when national occasions demanded, brass bands, the players being on the pay roll. The factory colonies of the Strutts were classic examples of benevolent despotism on a small scale, and it is interesting that Samual Slater, 'founder' of the American cotton industry, served his apprenticeship with the Strutts and that William Harriman was their first customer in America. Harriman's great-great-grandson was to become ambassador to Great Britain and governor of New York.

Shrewdly the Strutts learned by others' misfortunes. After fire had destroyed one of Arkwright's mills in 1781 and the famous Albion Mills in London in 1791, they built a mill at Derby and a warehouse at Milford using iron-framed buildings paved with brick. By 1803 they were building a mill at Belper which was completely iron-framed and internally heated. Not the least of the interesting contributions which Dr. Fitton and the late Mr. Wadsworth have made to the social history of technology is their perceptive and detailed account of the way in which emergent cotton technology married up with parallel developments in other fields. Well might Ure, in his "Philosophy of Manufacturers" (1835), direct attention to their little co-operative society which had a thirteen years trial before being abandoned. Close-knit and clean, their cotton colonies were the communes of the Peak, with the Strutts as benignant taskmasters.

W. H. G. ARMYTAGE

VIRUSES, GENES AND ANTIGENS

Advances in Virus Research

Vol. 5. Edited by Kenneth M. Smith and Max A. Lauffer. Pp. ix+376. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1958.) 9.50 dollars.

PROBABLY what most people first want to know about a collection of review articles is: Who is writing and what about? This is easily answered: J. B. Brooksby on "The Virus of Foot-and-Mouth Disease"; Herbert A. Wenner on "Psittacosis-Lymphogranuloma Group of Viruses"; Gunther S. Stent on "Mating and Reproduction of Bacterial Viruses"; G. Bertani on "Lysogeny"; Ph. L'Héritier on "The Hereditary Virus of Drosophila"; Forest Fulton on "The Measurement of Complement Fixation by Viruses"; Anne Buzzell and Martin Hanig on "The Mechanism of Hemagglutination by Influenza Virus"; but to comment usefully on this collection in a brief notice is more difficult. From the many facts and much speculation, what perhaps emerges most obviously is how disparate is knowledge about different groups of viruses and how varied are the techniques and types of approach to their study.

The first two articles are primarily concerned with viruses as pathogens, summarizing general properties, host ranges and the like. Information on the constitution of members of the Psittacosis group is much needed, for these are exceptional in that some diseases they cause are amenable to chemotherapy, suggesting they may be chemically more complex than smaller viruses. The next three articles are concerned with pathogenicity only as an experimental tool. The two on bacteriophages are excursions into radiobiology, genetics, the replication of nucleic acid, and the relationships between nucleic acid and protein synthesis, subjects for which these systems provide elegant experimental material and results rich in their scope for speculation. The juxtaposition of the article on the *Drosophila* virus and lysogeny stresses the similarities between the two systems and makes almost irresistible the temptation to extrapolate from the knowledge about bacteriophages to the constitution of the *Drosophila* virus about which nothing is known. That this virus was for long accepted as an example of cytoplasmic inheritance vividly illustrates how difficult it can be to define the boundaries between genetics and pathology.

The last two articles are not at all concerned with viruses as pathogens, but with other properties useful in assays. Fulton's scholarly analysis of the complement fixation test would be equally, perhaps more, appropriate to a volume on serology. However, there was no need to justify its inclusion for such questionable reasons as that viruses can rarely be obtained concentrated enough to use other serological methods and that virus workers are prejudiced against complement fixation. The precipitin test is used successfully with many viruses, and complement fixation is mentioned too often in the first two articles in this volume to suggest any strong prejudice against it. A third reason he offers is that "the complement test is both easier and more specific than hemagglutination techniques", the subject of the last article. Fulton says "Hemagglutination is bedevilled by non-specific inhibitors, and is a much more sophisticated technique than it first appears". In this, Buzzell and Hanig seem to agree, for they say "the ostensible simplicity of the hemagglutination reaction is, in reality, confused by a mass of diverse, and often contradictory evidence. Any mechanism which might be proposed to explain these divergences must be exceedingly flexible and endowed with so many parameters that it may be expected to explain anything". A cynic might be tempted to add that this is also true of mechanisms proposed for some other phenomena described in this volume.

Probably few virus workers will read all these articles with interest, but even fewer will find nothing of interest. The authors deserve credit for discussing their subjects critically and not simply summarizing all published work. It is less praiseworthy that reading is often unnecessarily tedious because some have rarely used one word when they could employ three.

F. C. Bawden

CHEMISTRY OF THE STEROIDS

Chemistry of the Steroids

By Prof. Charles W. Shoppee. (Organic Chemistry Monographs.) Pp. vii+314. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1958.) 50*s*.; 9 dollars.

FROM the author's preface it would appear that this volume has been written with the object of providing both a concise account of our present knowledge of the chemistry of the steroids and a more complete one of recent work, particularly when this has appeared since existing treatises on the subject were compiled. It is thus apparently intended to serve the dual purpose of a text-book and a work of reference. In the latter capacity it will prove invaluable, for it summarizes most of, if not all, the reactions which the individual steroids undergo and is liberally provided with references to the original sources. As a text-book it also contains many valuable features. It is useful to have collected together in one volume the principal data on which the accepted structures, conformations and configurations of the individual steroids are based; it is advantageous to possess brief summaries, translated in terms of present-day notation, of the fundamental contributions made by Windaus and Wieland to our knowledge of the structures of the sterols and bile acids; and it is convenient to have available outlines of the methods by which so many partial or total syntheses of important steroids have been effected. But its value as a text-book is somewhat diminished by the interspersing throughout the text of long passages—no doubt necessary in its capacity as a reference book—which consist of catalogues of chemical reactions. These make monotonous reading and destroy the continuity of the subject-matter.

As the title indicates, the book deals solely with the chemistry of the steroids. Nevertheless, brief statements of the functions or physiological activities of the individual compounds or groups are, when known, necessarily made. The subject-matter has been clearly and, so far as I can ascertain, accurately presented. Attention may, however, be directed to the following minor points:

The statement in the introductory chapter that the steroids are, "for the most part, saturated natural products . . ." appears to be misleading. For, while it is true that the bile acids follow this 'rule', the sterols, steroid hormones and other steroids do not.

In the chapter describing the sterols, each individual sterol is described in a separate section. Copro-

sterol (coprostanol) is not so treated, although it is mentioned elsewhere incidentally in the text. As a naturally occurring sterol, coprosterol should surely have been accorded individual treatment.

The occurrence of ergosterol in ergot, from which fact it derives its name, might have been mentioned. It is true that it also occurs in yeast, which now constitutes its chief source.

Finally, it seems a pity that a chapter has not been devoted to the steroid alkaloids, particularly as individual members of this group are occasionally mentioned in the text. E. STEDMAN

POLYMER CHEMISTRY

The Kinetics of Vinyl Polymerization by Radical Mechanisms

By Dr. C. H. Bamford, Dr. W. G. Barb, Dr. A. D. Jenkins and Dr. P. F. Onyon. Pp. xii+318. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1958.) 50*s*.; 8.80 dollars.

The Effects of Ionizing Radiation on Natural and Synthetic High Polymers

By Frank A. Bovey. (Polymer Reviews, Vol. 1.) Pp. xiii+287. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1958.) 8 dollars.

Physical Chemistry of High Polymers

By Dr. Maurice L. Huggins. Pp. 175. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1958.) 52*s*. net.

THE mechanism of vinyl polymerization has probably been studied in more detail than that of any other kind of chemical reaction, and in this book Dr. Bamford and his co-authors have presented a unified and thorough treatment of this important subject.

The two first chapters discuss the broad theoretical concepts upon which the subject rests, and the following four chapters summarize critically the experimental data for most of the important monomers and the relation of these results to the general theoretical developments. The chapter on heterogeneous polymerization—which refers only to those polymerizations in which the propagating radicals pass from one phase to another—is an original treatment based largely on the authors' own studies, and is particularly valuable since this subject is rarely dealt with in the standard works on polymer kinetics. The final chapter treats the statistical aspects of vinyl polymerizations and in particular the calculation of molecular weight distributions. This book is the most complete and up-to-date survey of the subject the reviewer has seen and it can be highly recommended to students and others interested in the synthesis of high polymers and to those chemists with wider interests in the mechanism of free radical reactions.

The book by Dr. Bovey is the first of a new series of "Polymer Reviews" (edited by Prof. H. Mark) in which emphasis will be placed on the principles and state of knowledge of newer developments in polymer chemistry, and it has set a very high standard. Although the importance of a study of the effects of radiation on dead and living matter has been recognized since the discovery of X-rays (1895) and radioactivity (1896), the greatest stimulus to the present-day intensive study of the subject has been the development of nuclear reactors and the application of high-intensity radiations. The consequent need to understand the effects of these radiations over long periods of time both on ordinary materials of construction and on living cells is obvious. In the use and application of high polymers it is clearly necessary to have a clear understanding of the mechanism of the beneficial aspects of radiation such as the improvement in mechanical properties of some plastics by cross-linking and also the scientific information which will permit the development of polymers which resist the effects of radiation. More important still may be the understanding of the effects of radiation on the polymeric material which constitutes cells and other living organisms.

This book is timely in that it reviews in a critical manner the basic results so far obtained in the study of the irradiation of high polymers. The opening chapters summarize the general properties and chemical effects of radiation and the radiation chemistry of high polymers in particular. The remaining chapters deal with the various synthetic and natural polymers in detail. The book as a whole is a thorough, critical and reliable review of this growing subject. It is a most stimulating account of the theoretical and practical aspects of what has rapidly become an important branch of polymer science.

Dr. Huggins's book is based on a course of lectures he delivered in Japanese universities and emphasizes his own important and fundamental contributions to chemistry. The book as a consequence is uneven in character. Brief reference only is made to many of the important aspects of polymer synthesis and properties whereas the valuable theoretical work of the author on the thermodynamic properties of solutions is described in detail. Other interesting chapters are those on dynamic properties of polymers and their solutions and on the general aspects of the structures of natural and synthetic high polymers. The author presents many original points of view and in this sense the book is of value to the specialist. Although covering the whole physical chemistry of polymers, the book is too condensed to be of great value to the student seeking a basic introduction to the subject. C. E. H. BAWN

MICROBES AND MILK

Dairy Microbiology

By Prof. Edwin M. Foster, Prof. F. Eugene Nelson, Prof. Marvin L. Speck, Prof. Raymond N. Doetsch, and Prof. Joseph C. Olson, Jr. Pp. xvi+492. (London: Macmillan and Co., Ltd., 1958.) 42*s*. net.

THE authors of this book are all professors or associate professors of bacteriology or dairy bacteriology in teaching institutions in the United States; this strengthens the impression, while not motivating it, that "Dairy Microbiology" is in several ways tailored to the American system of education. It is a form of students' text-book, though, as the authors hope, it should have considerable appeal in other fields, particularly technology, largely as a ready-reference book. Broadly, the first six chapters deal with the general application of microbiology to dairying, and the remaining nine with the microbiology of specific dairy products, waste disposal and the utilization of by-products. With the exception

of some of the illustrations, which are lacking in clarity and definition, the quality of reproduction is admirable.

"Dairy Microbiology" is indeed a veritable omnibus and very little material that is cognate has been overlooked, but its comprehensiveness seems sometimes to have been achieved at the expense of attention to detail. The need of the student to assimilate facts while only currently developing his critical faculties evokes the responsibility of authors to present him with something approaching the bare minimum consistent with accuracy and completeness. In some places detail is lacking, while other sections of "Dairy Microbiology" are rather overloaded with data. The style and presentation of material are frequently naïve and elementary though admirably clear and straightforward, but at times assume considerable erudition on the part of the reader in disciplines other than microbiology. Despite irritating mixtures of passive and imperative tenses in descriptions of techniques, there are few inaccuracies and inconsistencies and the book cannot be criticized on matters of fact. References, with titles, are a welcome feature, even be there few to publications appearing after 1954, the book having been published in the United States late in 1957.

The subject-matter is not confined to American practice, but systems and techniques foreign to the United States receive in most cases scant mention; there is, however, one outstanding instance where this is not so—the excellent and all-embracing chapter on the microbiology of cheese. Even here, though, the mechanization of Cheddar cheese manufacture is not covered, perhaps because of its so recent inception. There are, too, other important developments in dairy microbiology that are not mentioned, probably for the same reason, which, however good in itself, must still have the effect of dating the book: they include immersion cleaning as such, and calcium-free bacteriophage-resistant media for the propagation of starter cultures.

Perhaps the most disappointing feature of "Dairy Microbiology" is its homogeneity. Too many cooks usually spoil the broth, one imagines, by the addition of too many conflicting ingredients. In this instance, however, the authors have failed to inject into it any flavour of their own particular views or opinions, or indeed any strong flavour at all. This is particularly unfortunate since the list of individuals is indeed impressive, and many of their views are known to be both enlightened and stimulating. Although lacking any form of philosophy or impact, and leaving no profound impression other than of enormous compilation, "Dairy Microbiology" is, in that latter capacity, excellent value at so modest a price.

C. A. E. Briggs

APPARATUS AND APPLICATIONS OF MASS SPECTROSCOPY

Mass Spectroscopy

By Prof. Henry E. Duckworth. (Cambridge Monographs on Physics.) Pp. xvi+206. (Cambridge: At the University Press, 1958.) 35*s*. net.

THE branch of physics christened mass spectroscopy by Aston has experienced a remarkable growth. The types of instruments for ion analysis have increased in number and in performance, while their applications have extended into astronomy, biology, chemistry, engineering, geology and branches of physics other than nuclear. Prof. H. E. Duckworth has written a very concise account of the principles of positive-ion optics, the generation and detection of positive ions, and of spectrometers of all kinds used in the analysis of ions. The second half of the book summarizes the application of mass spectroscopy in physics, chemical physics and geophysics. In addition, there is briefer mention of other uses, such as gas analysis, stable isotopic tracer work and various applications in chemistry. The book concludes with a table of isotopic abundances and masses determined by mass spectrometric methods. The mass values for A less than 40 were measured by Nier and his collaborators, while greater mass values were based on the author's own research work.

The book is remarkably free from errors of a scientific kind, but some appear. Prof. Duckworth, in discussing spectrometers which provide first-order double-focusing for all masses plus second-order direction-focusing for one mass, specifically omits the common Mattauch and Herzog design of spectrometer which has the second-order focusing feature. Although some of the advantages of the vibrating-reed electrometer are specified, a most important advantage, the fact that there is no grid current, dependent on voltage, in parallel with the input current, is omitted. In discussing direction-focusing mass spectrometers with sector fields the statement is made that the resolution is independent of the angle of deflexion. This independence obtains only for symmetrical instruments. On p. 131 the (^{6}Li + n) reaction products are given incorrectly.

Almost every section of every chapter of Prof. Duckworth's monograph attributes the first study or first use of something to one or another person, and these assignments are in the main the same as those which have appeared in earlier books. There are, however, oversights and errors which might be corrected. For example (p. 13), the focusing properties of sector fields and Barber's rule were clearly illustrated by Aston in 1919. Aston (1919) also suggested focusing by a spherical condenser before Brüche and Henneberg (1935). Although Smythe, Rumbaugh and West (1934) first devised the general formula for obtaining higher-order direction-focusing in homogeneous magnetic fields, they are not mentioned in section 2·6. The emission of positive ions from heated salts and hot filaments is generally attributed to Gehrcke and Reichenheim (1906, 1907) as in section 3.2, but J. J. Thomson (1899) credits Elster and Geitel (1889) with the discovery that positive ions were emitted from hot filaments. C. J. Davisson (1912) credits the discovery of emission of positive electricity from heated salts to J. C. Beattie (1899). O. W. Richardson (1908, 1910) and his students, Hulbirt and Davisson (1912), carried out the first definitive research on identifying positive ions from hot salts and hot filaments. They thus clarified a difficult existing situation in which thermal ionization of residual gas atoms had been held responsible for the currents observed from uncoated filaments. This work, which antedated that of Dempster, is not mentioned.

Prof. Duckworth has written a concise but comprehensive book on mass spectroscopy which should prove valuable to anyone engaged in the analysis of ions. The large reference bibliography with individual page references to the text, and the index, both of which were obviously prepared with great care, enhance the value of the book.

K. T. Bainbridge

Administrative Medicine

Transactions of the Fifth Conference, October 29, 30, and 31, 1956, Princeton, N.J. Edited by George S. Stevenson. Pp. 197. (New York: Josiah Macy, Jr., Foundation, 1958.) 3.75 dollars.

THE Josiah Macy, Jr., Foundation has organized more than twenty conference groups of experts in different fields during the past fifteen years, each group meeting for a few days annually over a period of five years or more. Discussions, limited to twenty-five participants, are quite informal; one member introduces a topic and is subjected to frequent interruptions by way of questions or comment. Discussions are reported verbatim in the Transactions and the interruptions too often distract the reader's attention from the main issue. There are no formal conclusions and no recommendations are made. Three topics are presented in this volume: "Mental Health Elements in Administration of General Health", by Dr. Paul V. Lemkau; "The Administrative Role in the Management of a Mental Hospital", by Dr. Alfred P. Bay; and "Co-ordination of Local Resources: Techniques and Devices for Communication and Cross-fertilization", by Dr. T. P. Rees. Discussion on all three subjects dealt mainly with the means of integrating problems of mental health with other organized medical services and securing the active co-operation of the community in this integration. This appears to be a more difficult task in the United States than in Great Britain and the description by Dr. Rees of his 'open door' policy at Warlingham Park Hospital and his organized mental health service in Croydon aroused great interest. The selection, training and qualifications of hospital superintendents were also discussed, particularly in relation to geographically isolated hospitals, hospitals closely integrated with the community and hospitals of different sizes and types. G. A. CLARK

Amphetamine Psychosis

By P. H. Connell. (Maudsley Monographs, No. 5.) Pp. 133. (London: Chapman and Hall, Ltd., 1958. Published for the Institute of Psychiatry.) 21*s*. net.

CONSIDERING the number of years that the amphetamines have been available on the market and the wide range of their therapeutic usefulness, addiction to these drugs had always been regarded as rare and limited to psychopathic personalities who might have become addicted to anything. This latest Maudsley Monograph is calculated to shake the complacency of pharmacologists, psychiatrists, medical practitioners and manufacturers, and is therefore deserving of careful study. Dr. P. H. Connell, in a study of the literature, has found only six authenticated cases of amphetamine psychosis from Britain in the past twenty years, but he goes on to report another forty-two cases, of which twenty-eight were seen by him personally and the rest were discovered by inquiry among his colleagues. He emphasizes the remarkably close resemblance between the mental symptoms of amphetamine addicts and of those with paranoid schizophrenia, and points out that a single large dose of the drug may cause psychotic symptoms. The author's tabulation of the findings in the various cases is interesting and revealing, particularly when he touches on the relationship between the psychosis and the previous personality of the patient. Unfortunately, certain parts of this book must have been written some time ago, for we are told that no fewer than seventeen patients obtained their drug supply from the contents of amphetamine inhalers. An addendum mentions that amphetamine inhalers have been withdrawn from the market.

The second part of the monograph deals with the search for, and validation and use of, a biochemical test for detecting that a patient has been taking amphetamine. There is a bibliography occupying two and a half pages. W. R. BETT

Bibliography on the Effects of Ionizing Radiations on Plants, 1896–1955

By Arnold H. Sparrow, John P. Binnington and Virginia Pond. Pp. v+222. (Upton, New York: Brookhaven National Laboratory, 1958. Obtainable from Office of Technical Services, Department of Commerce, Washington, D.C.) 2.25 dollars.

THIS list of nearly 2,600 titles is arranged alphabetically by first authors with cross-references to include others. The articles are from 496 journals, 54 of them originating in the U.S.S.R. or countries of the Eastern bloc, as well as a number of books, symposium reports, etc. There is an excellent subject index occupying 90 pages. The volume is paper bound, but printing is clear and uncrowded on heavy paper.

The usefulness of this publication will be obvious to all who have experienced the difficulty of tracking down papers dealing with the biological effects of radiation in the large number of journals through which they are scattered. Although the list may not be complete, its coverage is comprehensive enough to make it invaluable to research workers in many phases of radiation biology, botany and agriculture. It is unfortunate that at the time of release it is nearly three years out of date: a supplementary list would already be useful and will soon, in this fast-moving field, be overdue. One hopes that the success of this publication will encourage the authors to prepare a second before very long.

ALMA HOWARD

Nuclear Scattering

By K. B. Mather and Dr. P. Swan. (Cambridge Monographs on Physics.) Pp. ix+469. (Cambridge: At the University Press, 1958.) 80*s*. net.

THE authors set out to describe the physics of nuclear scattering in a volume of 469 pages, the early chapters of which provide an introduction to the relation of nuclear scattering to nuclear forces and to the kind of apparatus which is used. The main body of the book is devoted to nucleon – nucleon scattering at both low and high energies, nuclear scattering and nuclear models and resonance. In this field, in which there is so much current literature, it is not possible within the confines of a single volume to be exhaustive and up to date at the instant of publication. However, the authors do present significant results available in mid-1957 and their interpretation in terms of nuclear forces and structure. At a few places the description of apparatus appears to be too detailed. Nevertheless, the selection from the information available has been carefully made. Although to an expert in any particular aspect of nuclear scattering, the treatment may appear rather sketchy, the book as a whole is a balanced representation. For this reason it will be welcomed by experimentalists and should provide valuable reading for the graduate student starting research as well as for those already actively engaged in this field.

THE ROYAL GREENWICH OBSERVATORY

By Dr. R. v. d. R. WOOLLEY, F.R.S.
Astronomer Royal

THE Yapp 36-in. reflecting telescope of the Royal Greenwich Observatory was brought into operation in September 1958. The move of the instruments from Greenwich to Herstmonceux is now therefore completed, and the Observatory can now look forward to an active observing programme with the equatorial telescopes, as well as with the meridian instruments.

There are six domes in the Equatorial Group at Herstmonceux, which contain instruments as follows. Dome *A* houses the 30-in. reflector. This telescope was formerly placed on the same mounting as a refractor, but they have now been provided with independent mountings. The telescope is available for spectroscopic or photoelectric work, and it is proposed to use it to test image-converter tubes, if these become available. The primary mirror was re-figured, but in the meantime it has been found that the secondary mirror is imperfect, and this is also being re-figured.

Dome *B* houses the Yapp 36-in. reflector. This is a comparatively modern instrument, for it was built by Grubb Parsons in 1934. It is equipped with a prism spectrograph, which is now being used to determine radial velocities of stars of special dynamical interest. It is, however, proposed to replace this prism spectrograph with a fast modern grating spectrograph, to be constructed in the Observatory's workshops.

Dome *C* at present contains the Isaac Roberts 20-in. reflector, on loan from the Science Museum, South Kensington. This small telescope is very valuable for photoelectric work, but as it is required by the Museum it will be replaced by a Schmidt reflecting telescope, for which, in fact, this dome was originally provided. It is proposed to equip the Schmidt telescope, which will have a long focal ratio, with objective prisms including Fehrenbach's double prism, with which radial velocities can be determined.

Dome *D* houses the astrographic telescope. This telescope is particularly valuable on account of the existence of old plates (some with epochs as old as 1885) taken with this and similar instruments from which proper motions can be derived by comparison between new and old plates. A programme of proper motions of stars, particularly those with special dynamical significance, is in hand. This telescope also carries the Markowitz moon camera, which is used at the time of full moon.

Dome *E* houses the Thompson 26-in. refractor. This is the telescope with which the Greenwich determinations of stellar parallax have been made. It is not generally realized that determinations of trigonometrical parallax are not really in a satisfactory state, and since so much astronomical reasoning depends ultimately on trigonometrical parallaxes, further programmes of parallax determination are of the greatest importance. It is to this work that this

Fig. 1. The Equatorial Group at Herstmonceux

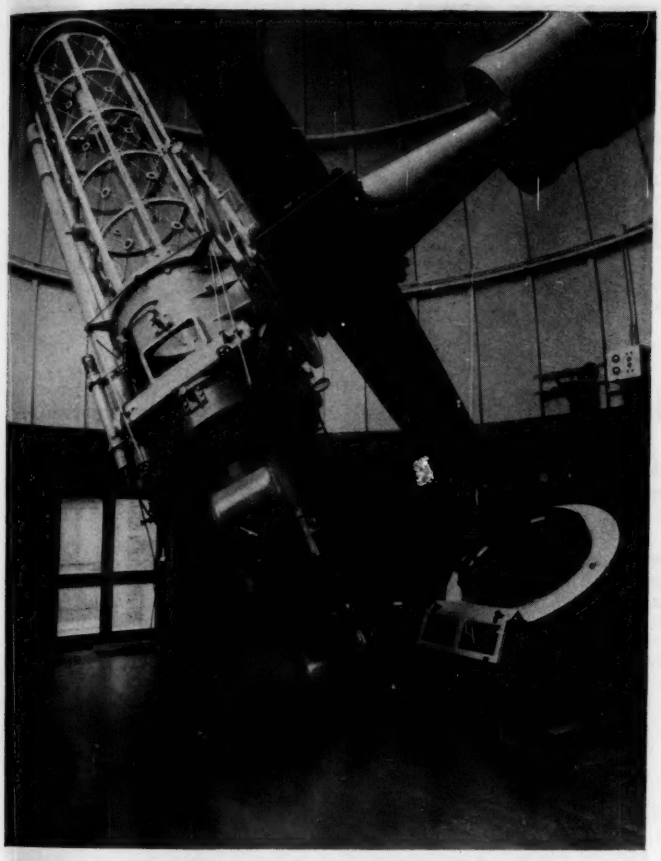


Fig. 2. The 36-in. Yapp Telescope

telescope will be mainly devoted. The dome is equipped with a rising floor.

Dome *F* contains the old 28-in. refractor. The polar axis of this telescope is in the form of an open hexagonal cage. It was designed by G. B. Airy and is a larger edition of a wooden cage which he built for the Northumberland equatorial in Cambridge. The ironwork of the 28-in. cage is one hundred years old almost exactly, but the telescope is not so old. It is larger than the original telescope and was put in the old cage at Greenwich from motives of economy. At Greenwich it could not point at the zenith because the eyepiece struck the floor as the zenith was approached. It is mounted higher at Herstmonceux and the telescope can now point at the zenith with a couple of feet to spare. It will be used for observations of visual double stars. These observations are extremely important for the determination of stellar mass. While double-star observing was prosecuted vigorously—or perhaps even overdone—at the end of the past century, not nearly enough attention is paid to the subject with large telescopes in the present decade, with the result that information which will be needed for the orbits, most of which are of long period, is not being secured.

The principal meridian instrument of the Observatory is now the Cooke Reversible Transit Circle. This instrument was constructed in 1933 and, had it not been for the Second World War, would have taken over from the famous Airy Transit Circle at Greenwich. However, detailed investigation of the instrument delayed its use on a full programme. The Airy Transit Circle remained in use until the Meridian Department moved to Herstmonceux.

Advantage has been taken of the interruption in the meridian work to introduce two major modifications to the Cooke instrument. The contact times from the transit micrometer are now recorded directly on punched cards by means of an apparatus known as *Epic* (electronic punch indicating chronograph), which has been designed and constructed in the Electronics Laboratory of the Observatory, and the visual circle-reading microscopes have been replaced by cameras. The films from the latter are measured on a screw measuring machine fitted with a digitizer, the output of which is recorded directly on punched cards. Thus, the observational data in each co-ordinate are obtained in a form most suited to automatic reduction.

The first major programme with this instrument was commenced in October 1957. This is part of the large international project for meridian observations of reference stars for the third Katalog der Astronomischen Gesellschaft, the new photographic catalogue. When compared with the second Katalog der Astronomischen Gesellschaft, this new catalogue will yield proper motions of some 200,000 stars. Twelve observatories are co-operating in this meridian programme. The Royal Greenwich Observatory has undertaken to make about 70,000 observations, including observations of reference stars, FK_3 and FK_3 Supplement stars, stars in the zones of the photographic zenith tubes, and a list of *O* and *B* type stars the proper motions of which are required for galactic research. More than 20,000 observations have been made during the first twelve months of the programme.

The Photographic Zenith Tube (P.Z.T.) was brought into operation during the latter part of 1955. The first two years observations have been analysed to give corrections to the assumed right ascensions and declinations of the stars in the 0·5°-wide zone centred on the Herstmonceux zenith.

Since the beginning of 1958, the time and latitude results have been sent regularly to the Bureau International de l'Heure in Paris, and the office of the International Latitude Service in Turin. The latitude observations are incorporated in the Service International Rapide, which was set up on the recommendation of the Dublin meeting of the International Astronomical Union in 1955 to publish co-ordinates of the pole with the minimum of delay, for use in the various national time services.

The time observations are used in the Observatory time service, and the latitude observations will be used in due course for correcting the declinations

observed with the transit circle for the effect of latitude variation.

In addition to the regular determination of clock error and latitude, observations extending over a long period can be used for deriving a correction to the adopted constant of nutation.

The other new buildings at Herstmonceux house the workshop, chronometer repair shops, the Time Department with its quartz clocks, and the Nautical Almanac Office. These premises were occupied in various stages during the past year, and the move from the old huts, in which some of the departments were temporarily located, is complete. (The Time Department moved from Abinger.) The huts, which were put up in front of the Castle to provide accommodation for an insurance company that was evacuated to Herstmonceux Castle during the War, have been removed and the ground grassed over.

The control of the national time service, which had been maintained from the war-time emergency station at Abinger Common, near Dorking, was transferred to Herstmonceux during 1957. The centre block of the new West Building contains the clock cellars in the sub-basement, and the clock room, control room and battery room in the basement.

With the opportunities afforded by the transfer to new permanent premises, much care and attention were devoted to the layout, and experience so far has shown the general arrangements to be sufficiently flexible to permit modifications and development.

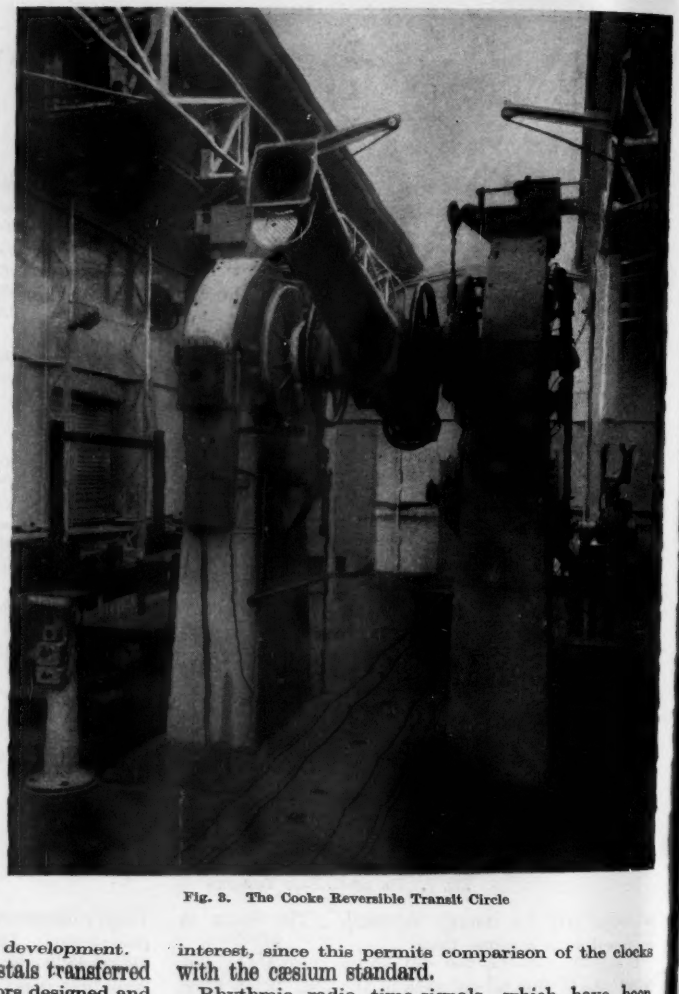


Fig. 3. The Cooke Reversible Transit Circle

The quartz clocks employ ring crystals transferred from Abinger and running in oscillators designed and made in the Electronics Laboratory. The control room equipment follows the general pattern of the Abinger installation; the decimal counter chronometers have been replaced by similar instruments of newer design; new radio receivers by Plessey and Racal have been installed in place of the war-time American receivers; in addition to single aerials on the roof of the building, a Wells array has been provided for the reception of nearby short-wave transmissions and an inclined-V array for reception of radio time signals from greater distances. A visual display unit has proved of particular value in facilitating accurate measurements on signals which have suffered distortion or which are subject to variable fading.

By means of a land-line link two standard clocks, one at the National Physical Laboratory and the other at the Post Office Laboratories, Dollis Hill, operate continuously running comparison meters at the Observatory. At any time the best clocks at the three stations may be used, in conjunction with the Photographic Zenith Tube observations, for the establishment of Greenwich Mean Time. The link with the National Physical Laboratory is of particular interest, since this permits comparison of the clocks with the cæsium standard.

Rhythmic radio time-signals, which have been controlled by the Royal Greenwich Observatory since 1927, are now regarded as obsolete and were discontinued in 1958. The 'English' type of signal, introduced by the Observatory in 1950 and still radiated twice daily, has now been generally adopted as a convenient standard. Arrangements are now in hand for the installation of control equipment at the transmitting station instead of at the Observatory, thus eliminating errors due to variations in the time of travel of the signal along the land lines.

Because of the irregularities inherent in a time-scale based on the rotation of the Earth on its axis, astronomers have adopted a new standard based on the annual period of the revolution of the Earth in its orbit around the Sun. Time determinations on the new scale are, for technical reasons, related to the motion of the Moon as observed against the background of the stars. A special Moon camera has been installed, and the Observatory has undertaken to measure plates taken at Perth, Canberra, Wellington and Naini Tal in addition to those taken at Herstmonceux.

H.M. Nautical Almanac Office has now been installed in its new offices in the West Building for

more than a year. Its work largely consists of the compilation and publication of the ephemerides and almanacs required by astronomers, navigators and surveyors. In recent years there has been introduced a policy of unification of its publications with those of the Nautical Almanac Office of the U.S. Naval Observatory; for the year 1960 the astronomical ephemeris (until 1959 published under the title of "The Nautical Almanac") will be completely unified with the corresponding American publication and published under the title "The Astronomical Ephemeris".

The Office is assisting other departments of the Observatory, particularly the Meridian Department, with the calculations involved in the reduction and discussion of observations. A small electronic computing machine (the Hollerith 1201) is being installed to expand the scope for this work, for the routine calculations of the Office, and for a limited range of theoretical investigations.

The precise motion of the Moon is of foremost importance in relation to the rotation of the Earth and to the determination of Ephemeris Time. The main task of the Office is the calculation of the lunar ephemeris; and it conducts a world-wide programme of occultation prediction, with the collection, reduction and discussion of all observed lunar occultations, as a small part of this task.

Work on the Newton telescope is now to be resumed (see *Nature*, February 28, p. 579).

THE AMERICAN MINIATURE NUCLEAR GENERATOR, *SNAP III*

By W. S. EASTWOOD, L. B. MULLETT and J. L. PUTMAN
Atomic Energy Research Establishment, Harwell, Didcot, Berks

SNAP III, standing for System for Nuclear Auxiliary Power, is a miniature device capable of powering the telemetering apparatus in a space rocket. Its source of power comes from the decay energy *generated by a source of radioactive polonium-210.* The energy is converted directly to electric current by attaching to the polonium capsule, which heats itself to more than 700° F., a series of twenty radial thermocouple elements in the form of wheel spokes. *The generator weighs 5 lb. and is 4¾ in. in diameter* × 5½ in. high. When originally charged, it held a content of 3,000 curies of polonium-210. At the demonstration at the White House some four months later, an output of 5 watts electrical power was delivered with an efficiency of 8–10 per cent.

The Martin Company of Baltimore built the device for the U.S. Atomic Energy Commission with the Minnesota Mining and Manufacturing Co., which owns patents on the thermocouples, as subcontractors. The contract was for 15,000 dollars, but the polonium source was quoted by the *New York Times as costing 30 million dollars. Other American* reports have given the basic cost of polonium as a hundred times less than this figure.

The polonium-210 is in many ways a convenient isotope to use, since it generates 5·3-MeV. alpha-*particles accompanied by a low proportion of gamma-*rays. The energy per disintegration is high and can be confined within the containing capsule, with small external background radiation. The whole apparatus may be handled for short times without receiving excessive radiation.

Polonium has a half-life of only 140 days, so that the useful life of *this 30-million dollar battery is* about four or five months. Only in a space rocket where results are paramount and weight reduction is essential can one imagine a use for such a device. Furthermore, the efficiency of the device falls off in roughly linear fashion with the difference of temperature between the hot and cold junctions, which will fall, of course, as the radiation source decays.

All alpha-emitting isotopes are a hazard, and polonium-210 is in the highest class of toxicity. In *Snap III* it is contained within two stainless steel shells and an outer one of molybdenum. Should the rocket head return to Earth, the need for three capsules will be apparent, since the maximum recommended human body-burden of radiopolonium is less than one hundred thousand millionth of the *contents.*

Polonium-210 is made by bombardment of bismuth with neutrons in a reactor, followed by chemical separation:

$$^{83}_{209}Bi + n \rightarrow {}^{83}_{210}Bi \rightarrow {}^{84}_{210}Po + \beta$$

Owing to the alpha-particle hazard, all handling must be carried out in a 'dry box', and this together with the heat generated in the sample makes the compaction of *3,000 curies into a small* capsule a fair technical achievement. The sealed containers are essential both for stopping the alpha-particles and to prevent diffusion of the polonium by nuclear recoil accompanying decay.

Various methods are known for conversion of atomic radiation to electricity. Direct use of the *charged alpha-particles would establish a voltage in* the megavolt range, which is somewhat impracticable. The electrons from a beta-active source can also be used directly to activate silicon, germanium or silicon carbide as a semi-conductor. The practical *choice is at present confined to those processes using* heat as an intermediary, and the most promising devices are thermionic diodes and semi-conductor thermocouples.

In a 'hard' diode, an efficiency of the order of 10–15 per cent has been obtained with a power density of 1 watt/sq. cm. of electrode by leaving very *close spacing (about 0·0005 in.) between cathode and* anode to reduce the space-charge effect. It is desirable to have a cathode of low work function and an anode of even lower work function for re-entry of the electrons. In principle, a diode could work with anode and cathode at the same temperature. In practice, for a diode of more reasonable geometry the space charge can be neutralized with positive ions, and much effort is being applied to the problem of introducing desirable ions such as cæsium. Any diode scheme, however, requires a temperature of the order of 1,000° C. or more.

Thermocouple devices have also been developed to similar efficiencies, but operating at lower temperatures. The old-fashioned metallic thermocouple is limited to low efficiency by excessive heat conduction, but semiconductors with poor heat transmission characteristics have revolutionized the field. The best material at present available is bismuth telluride doped with selenium and antimony to give negative and positive thermoelectric coefficients. A large number of these units can very conveniently be connected in series electrically and in parallel for heat flow. The efficiency is 5 per cent per 100 deg. C. temperature difference, but the maximum operating temperature is limited to the region of 250° C., above which the efficiency falls and the material is degraded. It is believed that an extension to 400° C. might be possible with special precautions. Lead telluride in alternate *n* and *p* type form is used in *Snap*. It has a lower efficiency for a given difference of temperature, but can be used at higher temperatures. The initial efficiency is quoted as 10 per cent, but after a half-life it falls to 5–6 per cent with an output of 3 watts. The initial power output is not directly quoted, but with 3,000 curies and 10 per cent efficiency it should be in the region of 10 watts. This would be consistent with an output after 140 days of the order of 2·5 watts, a factor of two down in power of source and a further two for reduced efficiency. There is insufficient information to determine why lead telluride was used and not bismuth telluride. It could be that bismuth telluride came a little too late, and the higher efficiency per 100 deg. C. is not a very important factor; or there might be a more cogent reason for the high temperature of the source connected with a difficulty in achieving a low temperature of the base in an artificial satellite.

Several other alpha-emitting isotopes might in theory be substituted for polonium, but it is unlikely that the natural or the trans-uranium elements would be available in sufficient quantities. The American press release suggested using the fission products $Ce^{-144}Pr$ (half-life 285 days) having a total beta-energy of 3·3 MeV. Here the compactness of the gadget must be sacrificed. Sources of high-energy beta-rays of this activity will be accompanied by a considerable bremsstrahlung background of X-rays which would require appreciably heavy shielding.

Apart from a better and cheaper supply, no great developments can be expected from the radioactive side of these generators. The methods of conversion, on the other hand, are the subject of considerable research, and new and improved alloys can be expected to raise the temperature of conversion and the efficiency. The stimulus for this work comes, however, from the more important possibilities of direct conversion of reactor heat or waste heat to electricity.

THE INDIAN INSTITUTE OF SCIENCE, BANGALORE, INDIA

GOLDEN JUBILEE

By Dr. S. BHAGAVANTAM
Director

THE Indian Institute of Science, which marked its golden jubilee by a special meeting on February 2, owes its existence to the far-sighted vision of the well-known philanthropist, the late Mr. Jamshetji Nusserwanji Tata. Unfortunately, the founder did not live to see the fruition of his idea, and it was left to his two sons, the late Sir Dorab J. Tata and the late Sir Ratan J. Tata, to carry out their father's wishes, with the active support of the late Lord Curzon, the then Governor-General of India, and Sir K. Sheshadri Iyer, who was at that time Dewan of Mysore. Mr. J. R. D. Tata, who is president of the Court of the Institute, opened the jubilee proceedings; the guests included the President of India, H.R.H. the Duke of Edinburgh and the Governor of Mysore.

The Institute may be deemed to have come into formal existence on May 27, 1909, the date of the vesting order of the Government of India. The first batch of students was, however, admitted only in 1911 with the Departments of General and Applied Chemistry and of Electrical Technology commencing to work. The Department of Organic Chemistry was added soon after. The Department of Biochemistry was opened in 1921 and that of Physics in 1933, when Sir C. V. Raman took charge as director of the Institute.

To the first director, Dr. Morris W. Travers, the distinguished chemist, and his colleagues, the Institute owes its sound foundations. Dr. Travers was succeeded by Sir A. G. Bourne (1915–21), Sir M. O. Forster (1922–33), Sir C. V. Raman (1933–37), Sir J. C. Ghosh (1939–48), who has just died (see p. 645), and Prof. M. S. Thacker (1949–55). I took charge in March 1957.

The Institute functions as an autonomous body in accordance with a scheme formulated by the Government of India under the Charitable Endowments Act. Its authorities include the President of the Republic of India as its *ex-officio* Visitor, a Court, a Council, a Finance Committee, a Board of Management for the endowed properties, a Board of Holding Trustees for the other properties, the Senate, the Faculties and the Director. The Director is the Chief Executive and Academic Officer of the Institute.

The Quinquennial Reviewing Committee, 1955, recommended that in place of the diplomas that it had been so far conferring on its students, the Institute should be enabled to confer degrees on them. On the orders of the Visitor, the Institute is now deemed to be a University under Section 3 of the University Grants Commission Act of 1956 for the purposes of that Act and is conferring the degrees of B.E., M.E., M.Sc., Ph.D. and D.Sc. instead of diplomas.

The accompanying figures (Table 1) give an idea of the Institute's expansion since its beginning.

Being in possession of well-equipped laboratories and as the leading postgraduate institution of the

Table 1

Year	Receipts (rounded to nearest thousand) Rs.	Expenditure (rounded to nearest thousand) Rs.	No. of students	No. of members of staff
1911	20,68,000	15,99,000	24	6
1919	3,24,000	3,41,000	73	7
1939	6,58,000	6,08,000	187	20
1947	32,06,000	36,67,000	221	50
1953	58,65,000	54,14,000	373	123
1958	64,05,000	66,64,000	561	157

country for advanced instruction and research in science and engineering, the Institute took up for investigation during the Second World War a large number of schemes of research sponsored by the Council of Scientific and Industrial Research, the Indian Council of Agricultural Research, the Indian Council of Medical Research and the Governments of Madras and Mysore. During that period, the Institute planned and established a Department of Aeronautical Engineering. When the War was drawing to a close, a further four-year expansion programme was launched with grants sanctioned by the Central Government. Under that programme, the Departments of Metallurgy (1945), Internal Combustion Engineering (1945), and Chemical Technology and Chemical Engineering (1951) were established; and laboratories for research in fermentation technology, food technology and pharmacology were set up. For the training of power engineers, a Department of Power Engineering was established in 1947 with laboratories for electrical, mechanical, civil and hydraulic and high-voltage engineering. A Section of Economics and Industrial Psychology, including industrial relations, and affording facilities for research in these subjects, was also started in the same year.

In 1955, under a scheme for the development of facilities for technical education, additional post-graduate courses in automobile engineering (1956), foundry engineering (1956), soil mechanics and foundation engineering (1957), electronic engineering (1956), ultra-short and microwave engineering (1956), line communication engineering and acoustical engineering were provided. Further facilities for research in technical gas reactions, physical metallurgy, hydraulic machines, internal combustion engineering, electrical measurements and measuring instruments, transmission, distribution and network practice have been added. Recently, a Department of Applied Mathematics and a Section of Industrial Engineering and Administration have been established.

The Library of the Institute is one of the best scientific and technical libraries in India.

The Institute publishes a quarterly entitled *Journal of the Indian Institute of Science*, containing original papers by the research workers of the Institute.

A noteworthy feature of the Indian Institute of Science is the objective itself with which it was founded, namely, for the provision of advanced instruction and the conduct of original investigations in all branches of knowledge that are likely to promote the material and industrial welfare of India. The broader the objective, obviously the more difficult will it be of fulfilment. However, the facts that we started with good foundations and established at a very early stage traditions of research in pure sciences like physics and chemistry, that we added later, and at appropriate times, specialized branches of technology like power engineering, metallurgy and aeronautics, and also that we did not quite neglect mathematics and even the humanities are, in my opinion, the principles that helped us to face our task and make its fulfilment come as near the ideal laid down by the founder as possible.

During the past fifty years, the Institute has grown to be one of the foremost centres of scientific research and advanced instruction in India. A large low-speed open-circuit wind tunnel of 9 ft. × 14 ft. test section was inaugurated during the recent jubilee celebrations. This tunnel is the only one of its kind in India, and will offer increased instructional and research facilities in aeroplane design. A modern a.c. network analyser, again the only one of its kind in India, has been in use for some time now in connexion with studies relating to power systems in the country. We are planning to put up and equip a modern acoustical laboratory to serve the purpose of training, research and testing in all branches of acoustics. There are many other lines of development which are not mentioned here for want of space. The Institute's contribution to the instructional aspect is reflected in the fact that more than three thousand of its alumni are now occupying positions of importance and responsibility all over the country in their fields of specialization. The research work done at the Institute has opened a new vista for generations of Indian scientists and engineers who go through its portals. Many young men and women from different parts of the country now eagerly look forward to joining the band of workers at the Institute.

The Institute is, to a high degree, autonomous in character. In the past, we confined ourselves to research and training, largely at the postgraduate level, and we propose to retain this feature in the years ahead. Thus we are able to direct our technological and scientific resources to carefully chosen specific purposes. We hope that against this background the Institute and those associated with it will have a great part to play in promoting the progress of India.

OBITUARIES

Sir J. C. Ghosh

Sir Jnan Chandra Ghosh died suddenly at the age of sixty-four at his Calcutta residence on January 21. I had been closely associated with him for some fifty years.

Sir J. C. Ghosh was a leader in physical chemistry when he was the professor and head of the Chemistry Department of the University of Dacca, which he joined in 1921, being appointed in London by Sir Philip Hartog, the first vice-chancellor of the University. He served this University loyally for twenty years and with conspicuous success as a teacher and research worker. By his devotion to science and his kindly nature, he attracted many young men and initiated them into scientific research. This seems to have been the best period in his career in the service of science and education.

In 1915 Ghosh published his first paper on the electrolysis of solutions by alternating electric current in the *Journal of the American Chemical Society*. During the First World War, Snethlage (*Z. phys. Chem.*, **90**, 1, 139; 1915) published some papers criticizing the Arrhenius electrolytic dissociation theory. I pointed out the weakness of Snethlage's views (*Medd. Nobel Inst.*, **3**, No. 15; 1916), and later developed my views in a paper to the Faraday Society, and a general discussion on the present position of the theory of ionization was organized in London by the Faraday Society on January 21, 1919. In this general discussion Ghosh's contributions to the basic conception of total ionization of electrolytes were considered and discussed and were favourably received by leading physical chemists of Britain, and papers by him were published in the *Journal of the Chemical Society*, London. However, other physical chemists scrutinized the conceptions and arguments of Ghosh and pointed out that they were not valid. Although Sutherland (*Phil. Mag.*, **3**, 161; 1902; **12**, 1; 1906) and Milner (*ibid.*, **25**, 742; 1913) introduced the conception of complete ionization, Ghosh's papers were mainly responsible for the development of this idea and its applications by Debye and Hückel in their theory of strong electrolytes. Later, Ghosh and his collaborators published some interesting papers on catalytic gaseous reactions and photochemistry, which have been followed up elsewhere.

During the Second World War, Ghosh was appointed director of the Indian Institute of Science, Bangalore, which expanded in various directions during his regime. In this period he was knighted, chiefly for his war services.

When Dr. Shyama Prosad Mukherji was appointed Minister in the Union Government, he took Ghosh to Delhi to assist in the expansion of technology in India. After a short stay in Delhi, he was sent to be the first director of the Indian Technological Institute at Kharagpur, West Bengal. Then he was appointed the first whole-time vice-chancellor of the University of Calcutta; but he had to give up this post after a short time on his appointment as a member of the Planning Commission for Science and Technology in India.

Lady Ghosh, three sons and two daughters survive him.

N. R. Dhar

Prof. W. Riddet

Prof. William Riddet, director of the Dairy Research Institute (N.Z.) at Palmerston North, New Zealand, died on December 30 at the age of sixty-two.

Prof. Riddet was born of farming parents in Ayrshire, Scotland. He graduated B.Sc. and N.D.A., N.D.D. (with honours) at the West of Scotland Agricultural College and the University of Glasgow. In 1921 he joined the staff of the West of Scotland Agricultural College, first as dairy instructor and later as lecturer. In 1925 he migrated to New Zealand to take up the then recently established Logan Campbell chair of agriculture at Auckland University College. In co-operation with Prof. G. S. (now Sir Geoffrey) Peren, then Walter Buchanan professor of agriculture at Victoria University College, Wellington, he organized the establishment, in 1927, of Massey Agricultural College, at Palmerston North, to which both professorships were transferred. At about the same time he played a leading part in the arrangements for the development of the Dairy Research Institute (N.Z.), an organization set up under the ægis of the N.Z. Department of Scientific and Industrial Research to undertake scientific research work as a service to the rapidly expanding dairy products manufacturing industry. Prof. Riddet was appointed the first director of this Institute.

Thus it was in the dual role of dean of dairying (and later vice-principal) of Massey Agricultural College and director of the Dairy Research Institute (N.Z.) that Prof. Riddet made his outstanding contribution to the advancement of dairy science and dairy practice, and thereby to the general welfare and prosperity of his adopted country.

Prof. Riddet had from the outset that very important attribute of a leader in teaching and research, an original and ranging mind. His interests covered a wide field; and wherever his interest lay his mind was active in devising and fostering ideas for investigation and research. Endowed with what seemed to be an inexhaustible reserve of energy, he devoted himself to his duties with an astonishing persistency.

As a teacher he set for his students very exacting standards. The value of his teaching is shown in the calibre of the men who came under his influence—they are to be found occupying positions of high responsibility in New Zealand, in Great Britain, and in many other countries. His spirit lives in the training and inspiration he has passed on to these students.

It lives, too, in the organization which he control'ed from its beginnings, the Dairy Research Institute (N.Z.). Under his guidance the Institute has gained an international reputation for its work on a number of aspects of dairying practice. While the publications describing this work do not often carry his name as author or co-author, all those who have worked under him will readily acknowledge their debt to him. With typical generosity he made no claims, and passed on his ideas without reservation. It was for him sufficient recompense that he could see the work being done and the Institute serving well the industry from which it drew its support.

The impact of Riddet's personality on the teaching of agricultural science, and on the dairy farming and dairy products manufacturing industry in New Zealand, will be evident for many years to come.

F. H. McDowall

Mr. F. W. James

On January 27, Mr. Francis Wogan James, librarian to the Imperial College of Science and Technology, London, died after years of illness most bravely and cheerfully borne.

From Haverfordwest he went to the Royal College of Science as a Royal Scholar in 1930, and after taking his degree in 1933 he became a research student in inorganic chemistry. During 1936–38 he was research assistant to the professor of highway engineering in the Department of Civil Engineering of the City and Guilds College—a transfer from one to another of the constituent parts of the Imperial College which made it easy for him, in later years, to take a broad view of the needs of the whole College.

In 1938 'Frank' James asked the Dean of the City and Guilds College for permission to apply for the post of College librarian—an appointment which, academically and financially, was junior to the one he was holding—in order to be in a better position

to contribute to science and learning by providing his colleagues and the students of the College with books and periodicals. How right he was the members of the College soon realized: although he never obtained a formal qualification in librarianship, he possessed a fine sense of the essentials of library service and a great love of books, and in the past twenty years the library has expanded in size much faster than the College itself and its value to the readers grew from year to year.

His work at the City and Guilds College was interrupted by war service, during 1941–46, in the Army. His work there was mainly concerned with motor transport and with radar, and his bent for these branches of engineering remained in clear evidence when he returned to his College on demobilization.

Frank James loved books, but he took an even greater interest in his readers. He knew hundreds of students by name and the subjects on which they were working, and—being a scientist himself—knew the importance of acquainting them, as soon as a journal arrived, with papers in their fields of interest. Several new lines of research at the College were stimulated by his understanding of papers on similar subjects appearing in what seemed unlikely journals. In addition, he was, when asked, ready to offer his help in the design of apparatus and showed a fine understanding of the construction and use of chemical and electronic equipment.

He possessed great charm and modesty and no member of the College had a greater fund of kindness. Students from overseas were especially grateful to him, for he could sense the needs of shy and lonely people and give them comfort for which they, in turn, gave him their devotion. Frank James will be sadly missed by countless friends who will long remember the kindness received from him and his charming wife. In 1958 he was appointed to be librarian in charge of all libraries at the Imperial College, and it is the College's good fortune that his spirit is alive in his staff. P. O. Wolf

Dr. Marcel Ballay

Dr. Marcel Ballay, president and managing director of the Centre d'Information du Nickel, Paris, died on February 2 after a short illness.

Born in 1896, Marcel Ballay entered early upon a career in metallurgy in the laboratory of the de Dion plant, of which he was afterwards appointed head, in 1925. In 1928 he joined the Centre d'Information du Nickel, first as technical manager, becoming later vice-president and in 1954 succeeding M. Jean Dhavernas as president. In 1955 he was appointed an officer of the Legion of Honour in recognition of his services to industry and to the teaching profession. He was a member of many learned societies in France and Great Britain. Under his direction the services offered to industry by the Centre d'Information du Nickel increased in importance, and it is as the head of that office and as a leading and respected metallurgist that Dr. Ballay will be remembered both in France and Great Britain.

NEWS and VIEWS

Airborne Radar at the Royal Radar Establishment: Dr. T. S. England

Dr. T. S. England, who has been promoted to deputy chief scientific officer and appointed head of the Airborne Radar Department at the Royal Radar Establishment, Malvern, graduated from the University of Durham with first-class honours in physics in 1937 and remained at Durham to undertake research on the heating effects of ultra-short radio waves in dipole solutions. At the outbreak of the Second World War in 1939, he joined the Air Ministry Research Establishment (later the Telecommunications Research Establishment) and worked primarily on the design of radar transmitters, initially at metric and later at centimetre wave-lengths, becoming head of the Transmitter Design Group in 1944. He was given leave of absence from Malvern during 1948–50 to take up a research fellowship in medical physics at the University of Durham, when he applied his extensive knowledge of electronics to studies of the effects of microwave radiations on living tissues and of microwave resonance phenomena in paramagnetic solids and liquids. He was awarded a Ph.D. for his thesis on these researches. On return to the Telecommunications Research Establishment, Dr. England was for a time responsible for research techniques in the millimetre band before being appointed a superintendent of the Radar Ballistics Division at the Royal Radar Establishment in 1956.

Defence Research Policy Staff: Mr. R. V. Whelpton

Mr. R. V. Whelpton, who has been promoted to deputy chief scientific officer and appointed Ministry of Supply representative on the Defence Research Policy Staff at the Ministry of Defence, took his M.Sc. at the University of Sheffield in 1938. After graduating in physics, he spent the next eight years with the research department of the Metropolitan-Vickers Electrical Company, where he worked on high-voltage research and on the development of the high-speed cathode-ray oscillograph. He was also engaged on investigations of transient phenomena in switchgear and the development of the electron microscope. In 1936 he joined Sir Robert Watson-Watt's original team on research and development of ground radar at Orfordness and Bawdsey. This work in 1940 was transferred to the Royal Aircraft Establishment at Farnborough, where Mr. Whelpton was also concerned with other aspects of radio research and development. In 1949 he continued on the same work with the Directorate of Electronics Research and Development at headquarters of the Ministry of Supply. In 1955 he was appointed scientific adviser on air defence to Supreme Headquarters Allied Powers in Europe (SHAPE) and was a member of the study group which led to the formation of the SHAPE Air Defence Technical Centre (SADTC) in The Hague. While at The Hague, as senior British representative, Mr. Whelpton pioneered efforts to

enable SADTC to promote integrated air defence for Nato. Mr. Whelpton is a Fellow of the Institute of Physics and he has published a number of papers, two of which have been awarded premiums by the Institution of Electrical Engineers.

Ministry of Supply: Mr. J. H. Phillips

Mr. J. H. Phillips has been promoted to deputy chief scientific officer and appointed to the headquarters post of director of Guided Weapons (Techniques). In this post he will be responsible for directing research and development on guidance and control techniques, advanced engineering techniques specially applicable to guided weapons and on propulsion. His career as a scientist has been almost entirely in the Government service. After taking an honours degree in physics at the University of London in 1937, Mr. Phillips worked throughout the Second World War on radio and radar problems, first at Bawdsey Manor and later at the Telecommunications Research Establishments at Swanage and Malvern. This was followed by a two-year term as guided weapons liaison officer in the British Supply Mission (now British Joint Services Mission) in Washington. Moving then to the Royal Aircraft Establishment, Farnborough, he worked for four years in the Guided Weapons Department at the most formative period of this new activity. Thence he was transferred to the headquarters staff of the Ministry of Supply on similar work, and for the past two years has been serving as head of the guided weapons group in the British Joint Services Mission, Washington.

Communication Principles at the Bell Telephone Laboratories: Prof. J. W. Tukey

Prof. J. W. Tukey, professor of mathematics at Princeton University and a member of the mathematical research department of the Bell Telephone Laboratories, has been appointed assistant director of research in communications principles at those Laboratories. Prof. Tukey will continue to occupy the chair of mathematics at Princeton, a post he has held since 1950.

A native of New Bedford, Massachusetts, Prof. Tukey graduated in chemistry from Brown University in 1936 and was awarded the degree of Ph.D. by Princeton University in 1939. He joined the technical staff of the Bell Laboratories in 1945. His work has covered development of new statistical techniques; broad analysis and synthesis problems related to complex weapons systems; and other problems with mathematical or statistical aspects. He was a Jacobus Fellow at Princeton in 1938–39, a Fellow of the John Simon Guggenheim Memorial Foundation in 1949–50, and a Fellow at the Center for Advanced Study in the Behavioral Sciences in 1957–58. Prof. Tukey is a member of the Division of Mathematics of the National Research Council and serves on several of the Council's committees, including the Committee on Atmospheric Sciences and the Committee on Behavioral Sciences. He has also served on a number of advisory committees to the United States Government, frequently in connexion with military problems.

Zoology at University College, Canberra: Prof. J. D. Smyth

The news of Prof. J. D. Smyth's appointment to the chair of zoology in the newly established Science Faculty in University College, Canberra, has been received with mixed feeling by Irish zoologists. A Dublin man and a graduate of the University of Dublin, he has spent the greater part of his academic life in his Alma Mater. In 1948, he returned to Dublin when he was made a Fellow of Trinity College and lecturer in zoology. In 1954, he became a professor of experimental zoology. Prior to his return to Dublin, Dr. Smyth held appointments in the Universities of Leicester and Leeds. Prof. Smyth is known to physiologists and parasitologists alike through his research on the physiology of tapeworms. This work chiefly concerns the culturing of the Pseudophyllidae *in vitro*. His technique permits the aseptic removal of the plerocercoid larvæ from the body cavity of fish and their cultivation in various media. By raising the temperature to 40° C., he induced the plerocercoid to mature and reproduce. One interesting result of his work indicates that development, as far as oviposition, depends on some bacterial by-product in the medium. Work on *Ligula intestinalis* has yielded fertile eggs which hatched into normal coracidia, proving a much-debated point that the tapeworm is self-fertile. Using a similar technique, Smyth also succeeded in showing that *Schistocephalis solidus* produced *in vitro* eggs capable of up to 85 per cent embryonation. Dublin has just conferred the degree of Sc.D. on Prof. Smyth—a fitting distinction and well earned. To him, his wife (Mildred Moore, also a graduate in zoology of the University of Dublin) and his two sons, his friends wish many happy years in the country of their adoption.

H. J. Hamburger (1859–1924)

The distinguished Dutch physiological chemist, Hartog Jakob Hamburger, was born at Alkmaar a century ago on March 9, 1859. He studied chemistry at the University of Utrecht and, after obtaining his doctorate in science, served for seven years as assistant in physiological chemistry to Franz Cornelis Donders. Having graduated M.D., he became lecturer in physiology and pathology at the Utrecht Veterinary School in 1888, and in 1901 he was elected to the chair of physiology at Groningen, where ten years later he was responsible for creating a magnificent new institute. He was president of the International Physiological Congress held at Groningen in September 1913 on the occasion of the twenty-fifth anniversary of its foundation.

A skilled designer of ingenious and deceptively simple experiments and a tolerant and kindly man, Hamburger is remembered eponymously for his 'phenomenon' (the chloride shift); his 'interchange', also called 'secondary buffering'; and his 'law', which states that, when blood is rendered acid, albumins and phosphates pass from the red blood corpuscles to the serum and the chlorides pass from the serum to the cells, and that the reverse occurs when the blood is rendered alkaline. As early as 1867 Nathan Zuntz had suggested that carbon dioxide is carried in the plasma by virtue of some substance present in the red blood corpuscles. It was Hamburger who furnished the final proof of this theory. Hamburger's best-known book is entitled "Osmotischer Druck und Ionenlehre in den medizinischen Wissenschaften" (three vols., Wiesbaden, 1902–4). He also contributed to our knowledge of calcium ions in phagocytosis and of næmolysis. A member of the Royal Academy of Amsterdam and recipient of many honorary degrees,

Hamburger died at Groningen on January 4, 1924, aged sixty-five.

Peaceful Uses of Outer Space

Mr. R. Allan, Under-Secretary of State for Foreign Affairs, stated in a written answer in the House of Commons on February 24 that last December the General Assembly of the United Nations set up an *ad hoc* Committee to study the question of international co-operation in the peaceful uses of outer space under United Nations auspices. The Committee, which is composed of eighteen member States, including the United Kingdom, the United States of America and the Soviet Union, is to consider the co-ordination of national research programmes. So far, the Soviet, Polish and Czechoslovak delegates have refused to participate in the work of this Committee, but Mr. Allan hoped that they will reconsider their decision.

Research on Road Accidents

In a written reply to a question in the House of Commons on February 25 as to the steps being taken to increase research on the prevention of road accidents, Mr. H. Nicholls, Parliamentary Secretary to the Ministry of Works, representing the Lord President of the Council, said that extensive researches with this objective generally were being carried out by the Road Research Laboratory. This covered such problems as the control of vehicles during emergency braking, improvements in tyres and road surfaces to give better adhesion on wet roads, improvements in vehicle and street lighting, and in helmets for motorcyclists. Safety aspects of motor-vehicle design to minimize injuries in road accidents were being investigated in the Slough area in co-operation with the police and the Medical Research Council. The staff available for this detailed study had recently been increased, and facilities for simulating accidents and testing individual components were being built up. Full co-operation existed, and the Laboratory studied research results obtained in the United States and elsewhere with a view of their application here. In 15 per cent of accidents studied in 1955–58 a mechanical defect in the vehicles had played an important part and about half the defects were in the brakes.

Chapelcross Nuclear Power Station

At the United Kingdom Atomic Energy Authority's nuclear power station at Chapelcross, near Annan, Dumfriesshire, the first of the four reactors, which became critical last November, has now been taken in service for the generation of electricity. The Chapelcross station, which will have a generating capacity of 184,000 kW. and will, when all four reactors are completed, feed about 140,000 kW. to the national grid, has been built by the United Kingdom Atomic Energy Authority as a dual-purpose station to provide plutonium and electricity. Another nuclear power station is being built by the South of Scotland Electricity Board at Hunterston in Ayrshire for the provision of electricity and will supply 320,000 kW. of power to the grid. The construction of Chapelcross is under the control of Messrs. Merz and McLellan, acting as agents for the Atomic Energy Authority's Industrial Group; this is the first occasion on which a private firm has been employed in this way in Britain on a major project. The official opening of the Chapelcross Station, by Sir John Crabbe, Lord Lieutenant of Dumfriesshire, will be on May 2, when it will be open to the public.

New Oceanographical Ship for Woods Hole

The sea-going fleet of the Woods Hole Oceanographic Institution, Massachusetts, was recently increased to five ships by the addition of the 92-ft. auxiliary ketch *Aries*, to do scientific work around Bermuda under Dr. John Swallow. Purchase of the ship was made possible with funds made available for the purpose by Mr. Richard J. Reynolds, of Sapelo Island, Georgia. *Aries* will be used mostly to study sub-surface ocean currents with the aid of Dr. Swallow's neutrally buoyant floats, which were used last year in the discovery of a counter-current under the Gulf Stream and in studying the outflow of Mediterranean water through the Straits of Gibraltar in the co-operative effort of the British National Institute of Oceanography and the Woods Hole Oceanographic Institution during the recent International Geophysical Year.

Built in 1953 of teakwood over steel frames, at the Camper and Nicholson Yard in Gosport, *Aries* was designed for world-wide cruising and is well appointed. Aft there is generous room for nine, and her forecastle has room for six. The ship is 70 ft. long on the water line, and has a beam of 19½ ft. and a draught of 12 ft. *Aries* is equipped with a 100-h.p. AEC Diesel engine capable of driving the ship at 8 knots and has a fuel capacity for 2,000 miles. Built to Lloyd's highest specifications, the vessel has copper sheathing on the bottom. The ship will remain under the command of her captain, John W. Gates; the Woods Hole Oceanographic Institution will operate her with a crew of eight. The fleet of the Woods Hole Oceanographic Institution also includes the 213-ft. *Chain*, the 142-ft. *Atlantis*, the 125-ft. *Crawford* and the 110-ft. *Bear*. Two small vessels, *Asterias* and *Risk*, are used for inshore work.

College Biology Courses on Television

The Fund for Advancement of Education established by the Ford Foundation has awarded Station *KETC-TV* and Saint Louis University a grant of 58,300 dollars to cover the academic costs for the production of a film series entitled "Principles of Genetics". The series of forty-five films, to be financed by the McGraw-Hill Co. of New York, are scheduled to be shown over *KETC-TV* network initially in the spring semester of 1960 and will serve as the basis for a regular college credit course in genetics. Simultaneous with the initial showing in Saint Louis, the films will be available to all colleges, universities, hospitals and industries throughout the world. Prof. John D. Dwyer, director of the Department of Biology, and Dr. Irwin H. Herskowitz, associate professor of biology in Saint Louis University, will serve as special consultants in the organization of scientific data for the series of films. The subject-matter will be recorded on film by leading specialists in the field of heredity, and is the first television series in biology, given by a number of leading scientists, of the Educational Television Station's plan for a College of the Air.

Brachiosaurus Exhibit at the Smithsonian Institution

The Smithsonian Institution has recently placed on exhibit in the Dinosaur Hall of its Natural History Building at Washington one of the largest dinosaur

limb bones ever known. It is the humerus (upper arm bone) of the sauropod dinosaur, *Brachiosaurus altithorax*, and it was discovered by D. E. Jones of Delta, Colo., who presented it to the Smithsonian. Geologically speaking, it is from the Morrison formation, of late Jurassic age (about 130 million years ago), in Montrose County, Colo. The bone is 6 ft. 10 in. long. *Brachiosaurus* was a giant among dinosaurs, much larger than the familiar *Brontosaurus*; it may have weighed as much as 55 tons. It is distinguished from other dinosaurs by the fact that its front legs were somewhat longer than its hind legs. This feature, the great length of the neck, and the projecting nostrils on top of the head seem to have been adaptations to its presumed habits. *Brachiosaurus* was a plant-eater that walked along the bottoms of lakes, lifting its head above the surface of the water to breathe. *Brachiosaurus* is known from North America, Africa and Europe.

Ethnographic Films

The Ethnographic Film Committee of Great Britain and Ireland presented three films at the National Film Theatre on March 1. Prof. C. von Fürer-Haimendorf, who has recently returned from nine months field work in a Sherpa village on the Nepal–Tibet border, presented a colour film showing the Sherpas at work in their fields and with their yaks. It also showed a Buddhist festival in a monastery headed by a reincarnate lama. David Attenborough went to New Guinea as a zoologist in search of birds of paradise. He and his cameraman, Charles Lagus, filmed courtship and wedding ceremonies of some of the highland tribes. The film also showed the native method of manufacturing salt and of making the stone axes which are now largely used for ceremonial and prestige purposes. The Iban dyaks of Sarawak were formerly renowned as head-hunters, and head-hunting ritual still plays an important part in their lives. Hugh Gibb, with the co-operation of Tom Harrisson, curator of the Sarawak Museum, made a colour film showing their slash-and-burn method of cultivating rice, tattooing, weaving, and many aspects of domestic life in the long houses in which entire communities live, each family in its separate apartment.

The Ethnographic Film Committee of Great Britain and Ireland is a committee of the Royal Anthropological Institute. It was established as the national committee in 1958 by the Joint Committee for Anthropological Research and Teaching, to co-operate with the national ethnographic film committees of other countries. In addition to sponsoring film programmes for teaching and public presentation, the Committee is preparing a catalogue of ethnographic films available in the United Kingdom.

Department of Scientific and Industrial Research Grants for Students

Under its second five-year plan, the Department of Scientific and Industrial Research proposes to increase substantially the number of its postgraduate studentships and fellowships in science and technology. By 1963–64 expenditure on this scheme is expected to exceed £1·5 million and the postgraduate students supported to number 3,800 in place of the present nearly 1,900. Grants for special research projects at universities and colleges under the Department's scheme, including provision for research in the human sciences in relation to industrial needs, are expected to increase three- to four-fold, to about £1·75 million in 1963–64. The latest issue of "Notes on D.S.I.R. Grants for Graduate Students and Research Workers" (pp. 28. London: H.M. Stationery Office, 1959. 1*s.* 9*d.* net) gives full details of the regulations governing such awards, with an appendix on awards tenable abroad. The rates for the latter, while varying from country to country, will be equivalent to those received by a student or a Fellow in Britain, and in addition, second-class rail fare and travel subsistence will be paid. Research fellowships vary between £700 and £850 a year and are normally held for two years. Under the studentship scheme, approved fees are paid to the appropriate authority and the maintenance grant paid to the student varies from £420 a year to students living in college, hostel or lodgings at Oxford and Cambridge, £400 at London and £340 elsewhere, to £285 to students living with parents in London and £270 to students living with parents elsewhere.

International Association for the Exchange of Students

The report for the year ended September 1958 of the International Association for the Exchange of Students for Technical Experience is accompanied by a survey of the first ten years of the Association in Great Britain during 1948–57. In the summer vacation of 1958, 776 students went abroad and 829 students were received; forty-two universities and colleges are now affiliated and twenty-four countries participate. Of the 4,968 students sent abroad from Great Britain under the Association in 1948–57, nearly a third (1,504) were from the Imperial College of Science and Technology; 272 were from the University of Durham, 263 from Birmingham, 220 from Bristol, 238 from Manchester, 228 from Cambridge, 186 from Glasgow, 180 from University College, London, and 173 from the University of Leeds. In 1958 it became necessary to restrict the nomination of students to those completing the penultimate year on an undergraduate course who had already had some previous industrial experience in Britain. Stress is laid on the contribution by British industry, and an evaluation of the exchange based on information from reports on 4,269 students indicates the undoubted success of the scheme. With scarcely any exception, the students proved genuinely anxious to work hard and gain the maximum benefit, but the vital necessity of great care in selecting students for the exchange is stressed.

Grants for Study Overseas

The British Council handbook entitled "Scholarships Abroad, 1959–60" (pp. iii + 27. London: British Council, 1959), to which the director-general, Sir Paul Sinker, contributes a foreword, lists by country awards offered by foreign governments and universities to enable British students to continue their studies abroad. Mostly they are offered annually, and the handbook includes particulars of conditions, value, duration and fares as well as of method of application and the closing date for receipt of applications.

Toxicology and Applied Pharmacology

After the recent appearance of a new British pharmacological journal, *Biochemical Pharmacology*, it comes as somewhat of a shock that a new toxico-

logical journal has been published in the United States. For each individual scientist it becomes increasingly difficult to keep up with the literature, and the immediate reaction to any new item on the list of journals is one of resentment. However, it is true that, as the editors of *Toxicology and Applied Pharmacology* point out, an increasing number of toxicological investigations are carried out in industry, government departments and universities, and that it would help the workers in toxicology to have the investigations collected in a single journal rather than scattered in many periodicals. It may, in fact, relieve pressure on the space available in the existing pharmacological journals if some of the toxicological material need no longer be published there. The new journal will only publish papers written in English, and the first issue consists of papers by authors from the North American continent. The editorial board, however, includes non-American members, so that contributions by authors from other continents will obviously be welcome. The first issue of *Toxicology and Applied Pharmacology* (1, No. 1; January 1959. Pp. iv+1–118. Published bi-monthly. Annual subscription, 13 dollars or 93*s*. New York and London: Academic Press, Inc., 1959) contains eleven papers, mostly on toxicity tests in animals. It is well produced, but it may be regretted by some readers that the summaries of the papers are in small print, since they are the most widely read part of a journal.

Report of the Imperial College of Science and Technology, London, for 1958

THE fifty-first annual report of the Governing Body of the Imperial College of Science and Technology, London, for the year ended July 31, 1958, records a further increase in the number of students. Full-time undergraduate students numbered 1,589 and postgraduate students 848, increases of 74 and 148, respectively, on the previous year, while part-time students (nearly all postgraduates) increased from 324 to 674. The teaching staff increased from 353 to 380, bringing the total of professors and readers to 36 and 62, respectively. The growing importance of nuclear technology was marked by the appointment of a reader in nuclear technology in the Department of Chemical Engineering, and the work done in the study of automatic control systems in the Department of Electrical Engineering is being extended to take account of the needs of other departments. At the end of the session the College's proposals for a new residential block to house nearly 400 students and provide refectory and common-room space for larger numbers was approved. Besides the statement of accounts, departmental notes and lists of publications, appendixes to the report include lists of special lectures, details of staff changes and Sir Alexander Fleck's address on Commemoration Day in October 1957.

Digitizers and other Equipment for Data Processing

DATA processing schemes are generally required to handle information which is originally in analogue form, that is to say, the signal takes the form of a continuous variable. For transmitting this information it is convenient to quantize it into discrete steps and then to transmit it in digital form. A descriptive catalogue published by Hilger and Watts, Ltd., London, and entitled "Digitizers and other Equipment for Data Processing", describes the principles of operation, and gives full technical information concerning a number of analogue – digital converters or digitizers, mainly of the type in which an input shaft drives a coded disk. Both mechanical and optical read-off systems are available. Details are also given of various ancillary equipment, including numerical displays, amplifiers and a typewriter for printing values of measured variables.

Scientific Careers in the Ministry of Supply

UNDER the title "An Invitation to Science Graduates", the Ministry of Supply and Central Office of Information have issued a booklet describing scientific careers open in the Ministry of Supply, copies of which are being sent to honours graduates in science as they qualify in British universities over the next two or three years. Besides indicating the nature of the careers, conditions of service, opportunities for promotion, the booklet gives particulars of how to apply.

Biological Effects of Space Flight

THE United States National Academy of Sciences–National Research Council has set up an Armed Forces–National Research Council Committee on Bio-Astronautics to advise the Armed Forces on matters concerning the biological or medical aspects of space exploration. The following scientists—representing different fields of endeavour in universities, private research organizations, and the Armed Forces—have been appointed to the Executive Council: *Chairman*, Dr. Otto H. Schmitt (Department of Physics, University of Minnesota); *Vice-Chairman*, Dr. Melvin Calvin (Department of Chemistry, University of California, Berkeley); *Members*, Dr. Howard J. Curtis (Department of Biology, Brookhaven National Laboratory), Dr. Paul M. Fitts (Department of Psychology, University of Michigan), Brig.-Gen. Don D. Flickinger (Directorate of Life Sciences, Air Research and Development Command), Dr. John D. French (Department of Anatomy, University of California Medical Center, Los Angeles), Capt. Charles F. Gell (Office of Naval Research), Dr. James D. Hardy (U.S. Naval Air Development Center, Johnsville, Pa.), and Col. Robert H. Holmes (Research and Development Command, Office of the Surgeon General, Department of the Army). Administrative responsibility for the Committee has been vested in the National Research Council's Division of Medical Sciences, under the chairmanship of Dr. R. Keith Cannan. The other members of the Committee are Dr. Sam F. Seeley (secretary) and Major Kay Cutler, of Air Research and Development Command. The full Committee on Bio-Astronautics —which will consist of more than a hundred members, of whom at least half will be nominees of the Armed Forces—will meet periodically to review scientific and technical problems, exchange information, and establish liaison between investigators with allied interests. It will concern itself with any field of science or of technology bearing upon bio-astronautics, including pertinent aspects of astronautics, biology, chemistry, medicine, physiology, psychology, and related interdisciplinary sciences.

The Association of Consulting Scientists

THE Association of Consulting Scientists has recently been formed, to act as a clearing bureau for inquiries for independent scientific services. Member-

ship of the Association embraces independent whole-time consulting scientists in the United Kingdom in all fields of science and technology other than medicine and civil, mechanical and electrical engineering. The founding members are mostly chemists and biologists, but physics and other sciences are expected to be represented soon. The new Association will operate in close collaboration with the Royal Institute of Chemistry and other professional institutes, and with organizations concerned with the co-ordination of British efforts in research, production and marketing. The following officers of the Association have been elected: *Chairman*, Dr. J. G. Davis; *Hon. Treasurer*, Dr. G. W. Ferguson; *Hon. Secretary*, W. H. Stevens, to whom inquiries can be addressed at 15 Hawthorne Road, Bromley, Kent.

The Leopoldina German Academy of Sciences: Elections

The Deutsche Akademie der Naturforscher Leopoldina, Halle, recently elected the following new members, in the sections indicated: *Anatomy*, Prof. Stefan Krompecher (Debrecen, Hungary), Prof. Dietrich Starck (Frankfurt am Main), Prof. Friedrich Wassermann (Lemont, Illinois), Prof. Wolfgang Bargmann (Kiel); *Surgery*, Prof. Willi Felix (Berlin), Prof. Karl Vosschulte (Giessen), Prof. Rudolf Zenker (Munich), Prof. Heinrich Kuntzen (Jena), Prof. Egbert Schwarz (Erfurt); *Zoology*, Prof. Manfred Gersch (Jena); *Mathematics*, Prof. Heinz Hopf (Zurich), Prof. O.-H. Keller (Halle); *History of Science and Medicine*, Prof. Pedro Lain Entralgo (Madrid), Prof. N. A. Figurovskij (Moscow), Prof. P. A. Juschkewitsch (Moscow); *Chemistry*, Prof. Josef Anton Goubeau (Stuttgart); *Botany*, Prof. Bohumil Němec (Prague); *Physiological Chemistry*, Prof. John T. Edsall (Cambridge, Mass.); *Odontology*, Prof. Wilhelm Meyer (Göttingen); *General Biology*, Prof. Eduard Kellenberger (Geneva).

"Some Palæomagnetic Investigations on Chinese Rocks"

Dr. A. E. M. Nairns has written in connexion with this communication in *Nature* of January 24, p. 254, stating that the present Fig. 1 is incorrect; the plotted points are mirror images of the actual points. On the original tracing, the graduations were drawn on one side of the sheet and the experimental points were, unfortunately, inserted on the other side; in preparing the block, the tracing was photographed from the wrong side.

Announcements

Prof. I. N. Sneddon, professor of mathematics in the University of Glasgow, has been awarded the Makdougall-Brisbane Prize for 1956–58 of the Royal Society of Edinburgh for his work on thermal stresses published in the *Proceedings* of the Society within the period of the award.

The Institution of Electrical Engineers is organizing an International Convention on Transistors and Associated Semiconductor Devices, which will be held at Earls Court, London, during May 21–27, together with an exhibition of scientific instruments employing such devices. Further information can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2.

The second conference on Liquid Fuels, organized by the Institute of Fuel, is to be held at the Palace Hotel, Torquay, during May 11–14, when twenty-one papers will be presented. Enrolment forms are available from the Secretary, Institute of Fuel, 18 Devonshire Street, London, W.1, from whom further information can be obtained.

A joint meeting of the British Radio Frequency Spectroscopy Group and the Groupement AMPERE will be held in the Physics Department, Queen Mary College (University of London), Mile End Road, London, E.1, during April 1–3 on "The Study of Molecular and Atomic Motions in Solids and Liquids by Radiofrequency Methods". Further information can be obtained from Dr. J. G. Powles at the address given above.

The Conference of the Oil and Colour Chemists' Association will be held in Edinburgh during May 5–9. The technical sessions, under the general title "A Survey of Polymers", will be held in the North British Hotel under the chairmanship of Prof. E. L. Hirst. Registration forms and further information can be obtained from the general secretary, R. H. Hamblin, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, Holborn, London, E.C.4.

A conference on Industrial Prospects in Nuclear Energy is being organized by the European Nuclear Energy Agency of the Organization for European Economic Co-operation. The conference, sponsored by the industrial federations of member and associated countries, and by the Council of European Industrial Federations, is to be held in Stresa, Italy, during May 11–14. Further information can be obtained from the European Nuclear Energy Agency, 38 Boulevard Suchet, Paris 16e.

A joint meeting of the AGARD Aeromedical and Flight Test Techniques and Instrumentation Panels will be held in Athens during May 11–15. The subject of survival and the reactions of the pilot to unforeseen hazards will be discussed. Special papers will be presented on: escape and survival techniques; medical and human engineering aspects of flight in non-conventional aircraft; and psychopathological stress problems in flying personnel, considered exclusively with reference to research required, or data obtained from research already carried out. Further information can be obtained from the Advisory Group for Aeronautical Research and Development, Organisation du Traité de l'Atlantique Nord, Palais de Chaillot, Paris 16e.

A joint symposium on Instrumentation and Computation in Process Development and Plant Design, organized by the Institution of Chemical Engineers, the Society of Instrument Technology and the British Computer Society under the ægis of the British Conference on Automation and Computation, is to be held at the Central Hall, Westminster, during May 11–13. Sessions will be devoted to improving the efficiency of existing processes; the design of new processes; the application of on-line computers; recent developments in instruments, on-line computers and computers for design; and the use of computer techniques in large and small companies. Preprints of the proceedings will be available; attendance is open to members of the sponsoring bodies and non-members on payment of a registration fee. Further details can be obtained from the General Secretary, Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1.

NEW CANADIAN FIRE RESEARCH LABORATORY

By R. F. LEGGET

Director, Division of Building Research, National Research Council of Canada

FIRE research in Canada advanced significantly with the opening on October 3 of the new Fire Research Laboratory of the National Research Council of Canada at Ottawa. The new building forms part of the Building Research Centre of the Council's Division of Building Research. It is situated on the extensive property of the Council known as the Montreal Road Laboratories, an area of about 400 acres in which the three engineering research divisions of the National Research Council and some other Council establishments are situated.

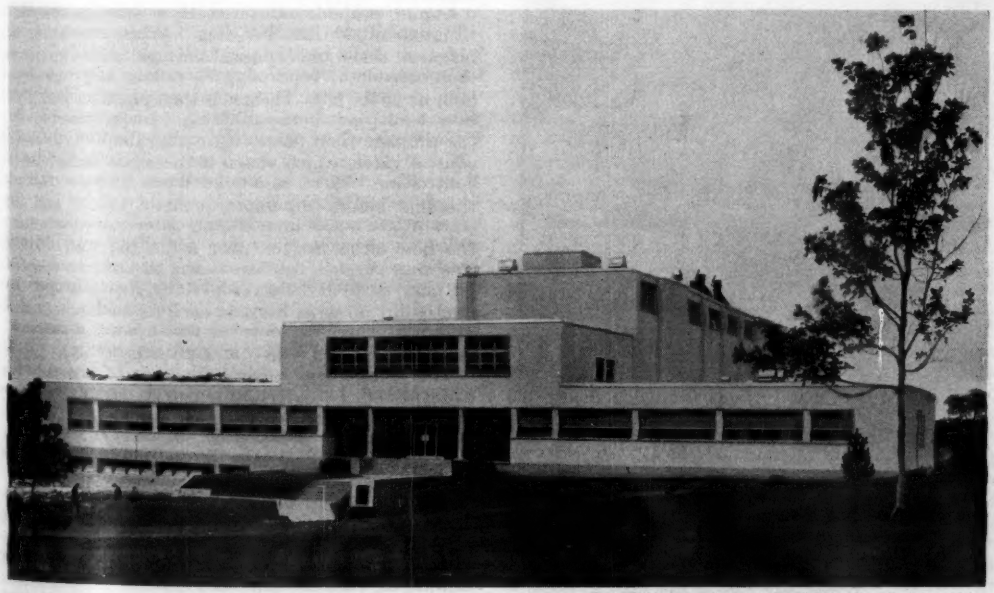
The official opening of the building was performed by Dr. F. M. Lea, director of the British Building Research Station, assisted by Mr. Dennis Lawson, the newly appointed director of the British Joint Fire Research Organization, both of whom had come to Ottawa especially for the occasion. The Canadian Division of Building Research has close liaison with both these British research organizations, the debt to which in the development of its work and in the planning of the new building was acknowledged by the director during the opening ceremony.

The opening of the new building followed a two-day conference on fire research and fire prevention, at which statements were presented regarding the work of all the major fire-prevention agencies of Canada. Speakers from the United States, Britain and Canada gave a review of fire research throughout the world. Some details of Canadian fire research were given to the conference, including preliminary results from full-scale burns of eight buildings in the small town of Aultsville, abandoned because of flooding caused by the construction of the international power dam on the St. Lawrence.

The fire research building (Fig. 1) has basically the shape of a large T, with offices and laboratories in the front wing, and the large furnace laboratory and a burn area for model studies in the rear wing. One-story additions have been erected on either side of the furnace laboratory to provide storage and workshop facilities, garage space for the station wagon used in field investigations, a control room for the operation of the fire-resistance furnaces, and additional laboratory facilities for hydraulic testing.

The building covers an area of 20,000 sq. ft. and has a total volume of more than 550,000 cu. ft., of which nearly half is made up of the volume of the 40-ft. high structure housing the furnace laboratory and the burn area. The total contract price, including all extras, which amounted to less than 4 per cent of the original cost, was 820,000 dollars, or a cost per cubic foot of less than 1.50 dollars.

The building, founded throughout on solid rock, consists of a structural steel frame supported on reinforced concrete. The outside walls, built of structural clay tile, are finished with stucco on metal lath on the outside and with glazed tile on the inside.



(Photograph: National Film Board of Canada)

Fig. 1. Fire Research Building of the Division of Building Research, National Research Council, Ottawa

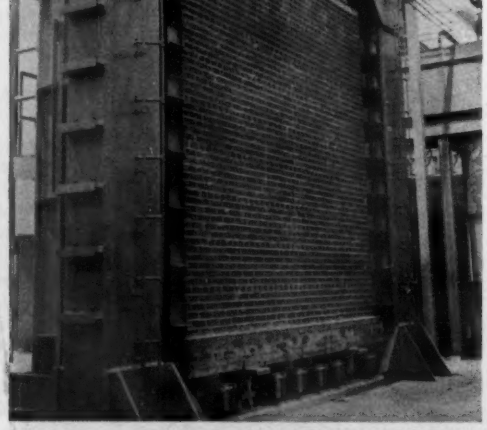
The area to the rear of the Fire Research Building was the site of an old quarry. Its rocky floor, which is approximately 5–10 ft. below the level of the surrounding area, provides an excellent outdoor experimental site on which to conduct large-scale tests on extinguishing fires.

The fire-resistance test facilities consist of two furnaces, complete with auxiliary equipment, together with the associated facilities for constructing, handling, conditioning and disposing of large test specimens. The design of the special facilities contained in the laboratory was carried out concurrently with the design and construction of the building itself, by a separate firm of consultants, Ewbank and Partners (Canada), Ltd., working in co-operation with the architects and engineers for the building.

The wall furnace (Fig. 2) consists essentially of a movable burner assembly open at the front, with the burners situated in the rear wall of the unit. The combustion chamber is completed when the front face of the burner assembly is fixed to the specimen under test. In this position the top of the furnace is immediately under the flue used for removing the combustion gases.

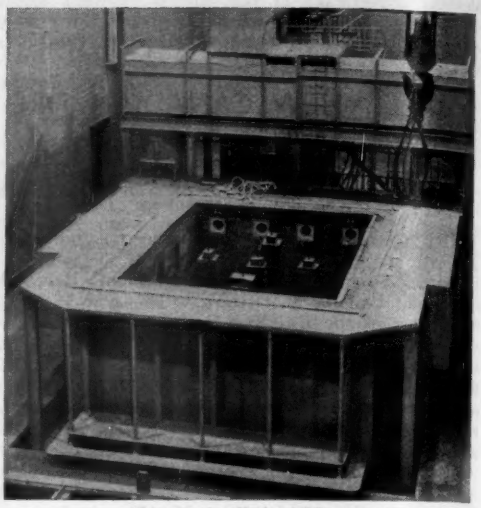
The size of the specimen exposed to the combustion chamber is 12 ft. by 12 ft., although the loading frame itself will accommodate a specimen 14 ft. by 14 ft. The heat in the combustion chamber is supplied by 100 burners having a capacity of 50 cu. ft. of gas per hour at a pressure of 25 lb./in.^{2}. The fuel used is propane, having a gross heating value of approximately 2,500 B.T.U./cu. ft.; thus the maximum total heat input is approximately 12,500,000 B.T.U./hr.

The floor furnace (Fig. 3), in contrast to the wall furnace, is a fixed installation. The burners are installed in the two long sides and the two flues are permanently connected to the common flue used for conducting the flue gases from the building. The combustion chamber is completed when the specimen is laid on top of the furnace.



(*Photograph: National Film Board of Canada*)

Fig. 2. Loading frame with wall specimen in wall furnace in the furnace laboratory



(*Photograph: National Film Board of Canada*)

Fig. 3. Floor furnace in the furnace laboratory

The furnace at present will allow a floor specimen to have an area of 12 ft. by 15 ft. exposed to heat. When using this furnace for testing beams it will be possible to extend a beam past the furnace wall and load this portion of the beam as well.

Heat is supplied by means of thirty burners (fifteen on each side), each burner having a capacity of 220 cu. ft. of gas per hour at a pressure of 25 lb./in.^{2}. As in the case of the wall furnace, propane will be the fuel, so that the gross heat input is approximately 16,500,000 B.T.U./hr.

Liquid propane is stored in a 1,750-gallon tank situated outside the building. When operating the furnaces, the liquid is passed through three vaporizers, each capable of vaporizing 70 gallons of propane per hour at 25 lb./in.^{2}. The gas is then piped underground in a 4-in. pipe to the building. Inside the building the propane then passes through a diaphragm motor control valve, which closes if there is a failure of the control air. There is a pilot flame by-pass valve in the line before the motor control valve, and two shut-off gas cocks immediately after this valve direct the flow either to the floor or to the wall furnace. The wall furnace has ten banks of burners with ten burners in each bank, while the floor furnace has five banks of three burners each on each side. Each group of three burners is fitted with a solenoid-actuated shut-off valve and pressure gauge.

The combustion control for both of the furnaces is furnished by a potentiometric temperature-programme controller which follows the time–temperature curve designated in the current U.S. Standard (ASTM *E*119–57, Standard Methods of Fire Tests of Building Construction and Materials).

The two large furnaces will be put to use immediately for carrying out tests upon the fire-resistance of building materials in current use in Canada. These tests must be done since the furnaces are unique in Canada, but they involve an element of research, and the furnaces will be used for research investigations whenever possible. In the laboratories,

studies will continue on the properties of foam as an extinguisher of fire, into the problems of radiation from fire and on more detailed questions such as those related to the burning characteristics of materials. The results of all work will be made available to the committees responsible for the National Building Code of Canada for incorporation into successive revisions. The Code is an advisory document published by the National Research Council of Canada, and has legal effect only when adopted by municipalities for their own local use. It is already in legal use in this way for well over one-third of the population of Canada. As its adoption spreads, the results of the fire research programme will therefore be of direct effect to a large proportion of the people of the Dominion.

CHANGING INDUSTRY

THERE are clear signs that the post-war period of steady expansion is coming to an end. European competition is increasing, and there is a formidable growth of productive capacity in every continent. Apparent over-capacity in industry, the coming of nuclear power, international shortage of capital and low raw material prices are all contributing to a readjustment of the world's economy and are posing a direct challenge to British management.

This was the theme of the national conference of the British Institute of Management which was held at Brighton during November 26–28, 1958. The variety of papers presented by many distinguished speakers gave the hundreds of delegates considerable choice of meetings to attend; this is one of the admirable features of the Institute's conference which commends it to so many members but also makes it impossible to describe adequately. In two days there were twenty-three separate meetings and at least twenty-five study groups at which the topics ranged from staff assessment and grading to the best use of scientists in industry, the balance between technological education and management education and the problems of accounting in large multi-unit undertakings.

In the opening address Sir Harold Howitt, one of the three members of the Council on Prices, Productivity and Incomes, emphasized that the chief challenge facing management is inflation. So-called creeping inflation with its cumulative effects may soon become galloping inflation and get out of hand. But it is no use paying lip service to the desirability of killing inflation unless one is prepared to take the medicine that is involved in the process. Nor is it any use putting all the blame for inflation on one or other section of the community or expecting it to take all the medicine. All must exercise restraint. Wage increases are not harmful if they keep within the increase in productivity, since prices can then remain stable and the increase in wages will have been real. In the industrial field as a whole, total profits after depreciation from 1950 to 1956 have been about one-third as much as wages and salaries; profits must bear their share of responsibility for inflation.

One of the most important contributions to the conference was made by Griffith Page, managing director of the National Union of Manufacturers Advisory Service, Ltd., who described the ways in which small firms were being helped towards greater efficiency. Five years ago the Union was set up as a department of the National Union of Manufacturers, with financial aid under the Conditional Aid Scheme, and with emphasis on management and production organization. The lines along which the service developed were decided by the nature of the problems presented by the firms who sought its aid, by conviction that efforts and resources should be directed towards making the maximum possible impact in terms of productivity and efficiency upon the general population of small firms, and by the necessity to make the service self-supporting.

The natural interest of the membership of the National Union of Manufacturers and occasional Press reports have been adequate to generate a flow of inquiries, the follow-up of which has kept a growing staff fully engaged.

Altogether, some five hundred firms, representative of a wide cross-section of the smaller firms, have used the service, and the Union's Advisory Service has been able to acquire an increasingly intimate understanding of the financial pattern, the management structure, the production organization and the problems of small firms. Although the promotion of work study as a principal agency for promoting higher productivity held, and does still hold, an important place among the objectives of the Advisory Service, it was necessary to take a wider view of the management problems in small firms. This led to the adoption of a survey technique which approximates to the American concept of the management audit. Such surveys involve an appraisal of the overall business position of a company, its industrial standing, its policy and objectives, financial position, management structure, sales organization and productive efficiency. Their purpose is to enable the National Union of Manufacturers Advisory Service, Ltd., to indicate in what directions companies can most beneficially take action to improve their prosperity and well-being.

After such a survey, recommendations are made, and these may cover any one or a number of areas of management responsibility. The firm may be advised to install one or other of the principal management techniques, of which work study is predominant, because it usually provides the necessary foundation for others, like production control and standard costing. The introduction of work study is one which requires an appreciable period of full-time assistance, and the Advisory Service staff of industrial engineers is available to shoulder the main responsibility for its introduction and to train members of the firm's own staff so that the schemes introduced shall be properly maintained. The Advisory Service seeks to assess the limitations and the potentialities of the smaller firms in the total business sense, to explain how sound principles of management and modern techniques of management can be applied in the context of their own highly individual situations, to indicate the advantages which can flow from their adoption and, in so far as it is necessary to ensure that this is adequately

accomplished, by helping them either on a part-time or full-time basis over a period.

In a thoughtful and stimulating paper concerned with the challenge of change in export markets, Mr. B. H. Dyson, sometime director and general manager of Hoover Overseas Production, Ltd., emphasized that, although many people think that Britain's troubles stem from trade unions, shop stewards, restrictive practices, cradle-to-grave social services, or nationalized industries, the restrictive outlook and practices of management could be more dangerous. The most dangerous factor in Britain to-day is acceptance of the lowering of the standard of expectancy. How can one expect a higher standard of living and yet apply less physical, mental and spiritual effort towards its attainment? The challenge of the change calls us to create the attitude of mind conducive to arousing the desire of achievement. One factor which can actively contribute to the conversion of high wages into low costs and competitively priced products into a higher standard of living is the continuous and progressive rise in both management and worker productivity. Future success will depend almost entirely on directors and management having the courage to accept change; products of superior styling and design; manufacturing at competitive costs, consistent quality and realistic delivery; good salesmanship and adequate service.

To-day with many directors and managers the home market takes precedence over export markets simply because the home market is familiar to them and its requirements fully understood. With export markets the profit margins are smaller, adding further to the temptation to rely on the more assured and less exacting demands of the home market. Only too frequently a company will take infinite trouble to appoint a representative to look after the Birmingham market, but will be content to appoint an agent (without even having seen him) to look after a whole country abroad.

The only way to explore the possibilities of business overseas is by personal visits to gain knowledge of the country itself, of the sort of competition which exists there, of the sales methods which will work most successfully, and of the field covered by other foreign competitors as well as by the nationals.

If the extent of the business potential does not warrant setting up an overseas company, the appointed representative should know details of the company's expectations, prices, terms of payment, stocks, service, advertising samples, methods of handling competitive merchandise, commission, profits, deliveries, expenses, literature and price lists.

Not enough training is being given for the export market. Not enough engineers from the countries now developing towards an individual economy are being offered postgraduate training with British engineering firms, while British sales and technical engineers going overseas for their companies are not being given the necessary additional training in the customs and language of the overseas countries to enable them to present British industry at its best.

Often in overseas markets a typical British design is not acceptable, and the overseas customer cannot always be sold the idea that the British home market is the acme of good design. Full-sized British egg-cups are not suitable for the small-size Indian and Asiatic egg, and lawn mowers built for the trim lawns of Britain are useless for Australia, New Zealand and uneven coarse grass. In India it is said that British motor-cars are recognized by a 2-in width of adhesive placed around the edges of the windows to keep out the monsoon rains. Style and colour are selling features, and here the product must be a fashion leader and not a fashion follower.

The design office and drawing-board are the cradle and kindergarten of production costs. If the design of the product and each individual component is not efficient from a functional or accepted standard point of view, no matter how perfect the manufacturing may be, the cost of production will be high. A factory in France is manufacturing 17,000 coffee mills a day that are sold all over the world at between 30*s*. and £2 each, and no competitor has been able to approach the value. A manufacturer of electric frying pans tooled up for 3,000 per week and has not been able to maintain 300 per week, because good as the value may be, the average housewife regards a frying pan as a 10*s*. 6*d*. article. An article which sells well at 1*s*. may not sell in a larger size at 1*s*. 6*d*. even if better value is represented by the larger size.

Research into the problem of designing for low-cost production is an important step towards enhancing sales. The main object should be to direct research into: (1) the reduction of the number of component parts; (2) the reduction in the number of production operations; (3) minimizing metal removal operations and the standardization of detail.

Efficient utilization of material demands a change of outlook on manufacturing costs. Often considerable time, ingenuity and expense are involved in designing and making machines and tooling aimed at reducing the direct labour cost by 10 per cent. A 10 per cent saving on direct material would show a much greater cost saving. Investigations into this aspect of cost reduction have indicated that often one must consider not only the value of the material in the product, but also the ratio of material utilization to the original material purchased. The design specification can assist production by: (1) reducing to a minimum the variety of finishes; (2) standardizing chemical or plated finishes that assist the economics of mechanizing the finishing processes; (3) commoning-up and standardizing on the undercoats for enamel finishes; (4) arranging that the variety of finish coats can be baked at a consistent time and temperature so as to aid the mechanization of dip, spray, electrostatic and baking operations to a conveyorized process.

Considerable attention must also be given to ensure consistent quality standards from machining operations. Often the production engineer neglects to define in the process operation sheet the inspection operations, stating in detail the dimensions and points which need to be checked. To 'motion study' a production operation and ignore the workplace and equipment supplied to inspection viewers is paying lip service to the important job of maintaining consistent quality at controlled prices.

Nothing is more disappointing to a customer than transit damage, whether it be frost-bitten fruit trees, scratched furniture, a chipped surface plate or an out-of-line machine tool. Correct packing is essential and can be costly. Special containers and crates to assist transportation may be necessary. Shipping space and conditions have to be considered; under the water-line stowage may need extra protection.

In the American and Canadian market, especially, the styling and presentation value of the package is very important as a sales feature. The product may

have a "good old English reputation"; but the pack must be cleverly styled so that the old tradition is presented in conformity with the currently accepted mode.

The method to be used in marketing a product in a specific country is a top-level decision. If the potential market is large enough it is invariably best to establish a subsidiary company. It is certainly more satisfactory to appoint an importing house to act as agent or a company to handle the sole distribution rights than to accept orders from all and sundry.

One of the most unusual management training centres in Europe was described by Clark E. Myers and F. A. Kirby. The school was set up at Lausanne in September 1957 by the Nestlé Alimentana Co., and is designed to provide a nine-months course in business administration for middle management executives from all over the world. The staff consists of American professors recognized in their fields for teaching, publication, consulting and research who wish to continue working in an environment which closely resembles an academic situation.

During the first two years, executives have attended the course from companies in Australia, Belgium, Brazil, Canada, Chile, Cuba, Denmark, Egypt, England, France, Germany, Greece, Holland, Italy, Mexico, Puerto Rico, Malaya, South Africa, Spain, Sweden, Switzerland and the United States. Patterned after the middle-management programme of the Harvard Graduate School of Business Administration, the programme is designed primarily for men whose average age is about thirty-five and who fall within the age range of 30–40.

Based on the Harvard experience, from which background nearly all the professors are drawn, the case method is used almost exclusively. The major exceptions are several weeks of the programme where the elements of accounting and statistics are taught. The policy is based on the belief that experienced men can achieve a greater sense of stimulation, motivation and involvement by dealing with actual business situations.

One-third of the course is devoted to the quantitative data areas of control and finance (which includes such work as statistics, accounting, index numbers, budgeting and data processing); one-third to distribution (including retailing, marketing, sales management and international trade); one-sixth to production, factory management, general management and business policy; and one-sixth to human relations, personnel and labour problems.

The professors teach on three consecutive days either at the beginning or end of the week. The remainder of their time is devoted to writing new teaching materials better suited to an international school. In their employment agreements with the Institut pour l'Etude des Methodes de Direction de l'Enterprise they have agreed to forgo all consulting activities and devote full time to teaching, writing and research for the Institute.

The professors are assisted by research associates. These men have nearly all studied or worked in the United States, and among them have knowledge of nearly every European language. They travel with the professors and assist in research and the writing of new teaching notes and case problems.

Through the development of these materials and cases, the professors gain additional insight into European business affairs, provide better class-room data for the participating executives, assist in publicizing the school and stimulate the interest of European executives in business research and education.

During the first year about two hundred 'pieces of work' were produced. These included new cases, translated cases, technical notes, and a major study of food distribution in seven European countries.

With the increased emphasis on international business, with the coming impact of the Common Market and the free trade area, the directing staff of the Institut pour l'Etude des Methodes de Direction de l'Enterprise believes that such an institution with an international outlook is both desirable and necessary.

Of the many other papers, two of the most outstanding were forecasting and controlling the return on capital involved by J. A. Scott, chief financial executive of Hayeshaw, Ltd., and the effect on quality of administration on technical and commercial efficiency by A. C. Durie, general manager (administration) of Shell-Mex and B.P., Ltd.

TURBIDITY CURRENTS

IT was thought for many years that the sediments on the floor of the deep ocean were laid down slowly, the rate of deposition being of the order of millimetres a century. Extensive coring has shown, however, that there are many layers of sand, some with shallow-water fauna, interbedded with the normal deep-water clays and oozes. Turbidity currents, in which a relatively thin layer of sediment-laden water flows rapidly down-slope, have been suggested as a possible mechanism. These currents could deposit such layers of sand in a matter of hours.

When first introduced rather more than twenty-five years ago, the notion of turbidity currents was received sceptically; since then large velocities have been postulated, but it is difficult to imagine their being produced by such contrasts in density on such gentle slopes. Nevertheless, the idea is now generally accepted by marine geologists, or at least it would appear so from the discussion of the subject held at the Royal Astronomical Society on November 28. Dr. G. E. R. Deacon acted as chairman.

The evidence supporting the turbidity-current hypothesis was reviewed by Dr. A. S. Laughton. He pointed out that sediment-laden underflows are well known in lakes, being particularly well documented in the case of Lake Mead. It has been estimated that, of the two million tons of sediment deposited in Lake Mead during 1935–48, an appreciable fraction was deposited by turbidity currents extending along the whole length of the lake. The flows are slow, consistent with the slight contrast in density and the gentle slope, but retain their identity for more than a hundred miles.

The classical case of a turbidity current in the ocean is that produced by the Grand Banks earthquake of 1929 which, by breaking a succession of telegraph cables over a period of 14 hours, provided estimates of the velocities reached. These decreased

from almost 30 m./sec. to about 6 m./sec. as the slope decreased from about 1 in 100 to 1 in 1,000. It seems that this rapid and highly turbulent flow traversed some 1,000 km. and had a breadth of some 300 km. For some geologists these are unimaginably high velocities on this scale, but Heezen and Ewing, who suggested the turbidity-current explanation, have much to support their view. Not only were several of the cables later found to be buried so deeply as to be irrecoverable, but two cores which Heezen later obtained in the area both had thick sand layers of shallow water origin overlying the normal deep sea deposits.

Turbidity currents in lakes and in the ocean were linked by the laboratory investigation of Keunen, who produced similar flows on a small scale by the sudden release of fluid mixtures of water, clay and sand. The important result was that a simple hydraulic formula was found to apply, implying that the effect of the overlying fluid could be neglected, as could the acceleration in the flow. Turbidity currents in lakes, ocean and laboratory were not inconsistent with the simplest formula used to describe river flow. Using this formula, Keunen estimated the depth of the Grand Banks turbidity current to vary between 270 m. and 120 m. during its passage.

Dr. R. Stoneley, in discussing the suggestion that the breakages of submarine telegraph cables, following the Grand Banks earthquake of November 18, 1929, occurred through the passage of a turbidity current, remarked that the hypothesis has the merit of being more free from *ad hoc* assumptions than some of the other explanations proposed. The idea deserves further examination from the hydrodynamical point of view. In particular, two aspects have to be considered, namely: (*a*) whether the turbidity current would spread longitudinally too greatly to be effective; (*b*) whether the motion of the current would persist over distances of the order of 1,000 km. without being damped out by viscous forces.

Under (*a*), the longitudinal spread of the mass of water charged with sediment has much in common with the problems of the surge following the breaking of a dam and of the subsidence of a column of water, considered respectively by R. F. Dressler, and by W. G. Penney and C. K. Thornhill. A rough calculation based on the work of these authors suggested that the depth of the current as envisaged by Kuenen would be much too great; the hypothesis would be more workable if the current had a thickness of only a few metres. Question (*b*) depends on the viscous drag of a stream at high Reynolds numbers; the theoretical and experimental work of G. H. Keulegan on arrested saline wedges suggests a much lower drag coefficient than is appropriate for lower speeds. Keulegan's experiments show that the logarithm of the drag coefficient depends linearly on the logarithm of the Reynolds number, and an extrapolation of this result indicates a thinner turbidity current, with a vertical thickness of about 5 metres. Such a thickness would help to meet the difficulty mentioned under (*a*).

Further investigations of these hydrodynamical problems are very desirable, and examination is needed of the effectiveness of such a current in transporting and sorting sediments to the degree required.

Two points relating to Dr. Stoneley's contribution were made in the subsequent discussion. It was pointed out that in laboratory experiments the downslope turbulent flow of a fluid under a less dense fluid leads to the formation of a somewhat bulbous 'nose' which travels only a little slower than the body of the fluid. The speed of the 'nose' is considerably less than the long-wave velocity in a perfect fluid. An adequate theory is not yet available. It was also remarked that the diminution of the drag of the sea-bed with increasing Reynolds number may be unjustified if the bottom is hydrodynamically rough. Observations show no decrease of drag coefficient with increasing velocity in the high Reynolds numbers (greater than 10^7) of tidal streams.

Dr. T. H. Ellison based his contribution on the work he is doing in collaboration with Dr. J. S. Turner. Their investigation concerns the ventilation of coal mines, but is applicable to the many situations in Nature in which a thin layer of turbulent fluid flows between a boundary and a relatively quiescent underlying or overlying fluid of different density. These include katabatic winds in the atmosphere and what appear to be katabatic bottom-currents in the ocean, as well as the many complicated phenomena observed in estuaries. Turbidity currents are a special case in which the turbulent fluid is made heavier by suspended solids. Some dust storms in the atmosphere are probably similar phenomena.

In the case of turbidity currents it seems that a relatively simple hydraulic theory would describe the observations if the friction and mixing with the overlying fluid could be neglected. It is therefore necessary to make some estimate of the amount of the non-turbulent fluid which would be entrained into the gradually thickening layer of turbulent fluid flowing beneath it. The rate of flow into the lower layer can be expressed as EV, where V is a typical velocity of the lower layer. E is the so-called 'entrainment constant', and if the two layers had the same density, $E \simeq 0{\cdot}08$. In this case the interaction of the two fluids could by no means be neglected. However, E decreases as the hydrostatic stability increases and it is reasonable to assume that E is a function only of the Richardson number, Ri, which is a dimensionless measure of the stability given in this case by $Ri \equiv (\rho - \rho_0)\, gh/\rho V^2$, where g is the acceleration of gravity, ρ, ρ_0 are the densities of the lower and upper fluids, and h is the depth of the lower fluid. Two sets of experiments have been made to determine E in relation to Ri. The results are scattered but agree that for $Ri > 0{\cdot}8$, which is the case in turbidity currents, then E becomes very small. The interaction between the two fluids is much reduced by the strong hydrostatic stability, and it is for this reason that a turbidity current can retain its identity for a long period and that the flow can be described by a simple formula applicable to river flow. Ellison's results are therefore broadly similar to those based on Keunen's work and support his conclusion: turbidity currents are compatible with our present knowledge of turbulence in stratified fluids.

The discussion which followed showed almost complete acceptance of this point of view; those against the turbidity-current hypothesis were either absent or silent. This is not to say that no problems remain. We know little of the ways in which turbidity currents are started or of the factors which determine whether water laden with sediment will behave as a heavy fluid or as a sloppy sort of solid. How often do turbidity currents happen? Were they stronger and more frequent during Ice Ages, and could they then have cut submarine canyons?

They presumably happen so infrequently that they make no contribution to the economy of the bottom water. For the same reason there is little hope of direct observation, although bathyscaphists report

that they have started mudslides when landing on steep slopes. Attempts to start them by using explosives in canyons have had little success. Altogether, considering its potential importance in the formation of abyssal plains and the structure of some sedimentary rocks, the turbidity-currents hypothesis seems to have had little influence on marine geologists. It is surprising, for example, that following the classical Grand Banks turbidity current only two cores have been collected from the area—and they apparently during borrowed time from a cruise with other objectives. Both these cores, taken some 20 km. apart, have sand layers at the surface. Below this, each has further layers of sand, but there is so little correlation between them that one can only speculate as to the horizontal structure. Taking closely spaced cores is technically difficult, time-consuming and expensive, but in some areas the expense would surely be justified.

H. CHARNOCK

THE BRITISH COUNCIL

REPORT FOR 1957–58

THE annual report of the British Council for 1957–58* includes a general survey of the year and is preceded by an article on the printed word by Sir Charles Snow, which stresses the importance of the work the Council is doing in this field on an expenditure of only £17,000, but urges the need for expansion. The report is accompanied by a separate account of the Council's work for visitors and students from overseas. More than half the report is occupied by appendixes listing the officers, executive committee, advisory committees and panels, with their membership, and giving particulars of university interchanges, courses and study tours, etc., arranged by the Council in the United Kingdom or overseas, exhibitions and publications, and an analysis of the estimates and accounts.

The increase in the Government grant for 1957–58 to £3,378,271 out of gross expenditure of £3,867,899 enabled the Council to start improving the supply of English teachers and teaching material for overseas and other work in accordance with Government decisions contained in the White Paper on Overseas Information Services. Further activities will be possible in 1958–59 with the increase of nearly £650,000 on the original estimates for 1957–58. For this year the Council is recruiting, or helping to recruit, on improved terms, for about seventy overseas teaching posts in English in schools, training colleges and universities, chiefly in Asian countries. It is also co-operating closely with a unit established by the Ministry of Education to assist in placing satisfactorily the returning teacher. Much is being done abroad to help overseas teachers of English, and the Council has also been closely associated with the new School of Applied Linguistics in the University of Edinburgh, to which one of its most experienced English-teaching specialists is being seconded. The Council is contributing £5,000 towards the establishment of an Overseas Visual Aids Centre to further increased and more efficient use of visual and audio-visual aids in formal and informal education overseas.

The specialist tours arranged by the Council include an advisory unit at the request of the Burmese Government of Prof. H. F. Humphreys and Mr. W. J. Deacon to examine and report on the state of education in Burma, a visit to Turkey of thirteen British surgeons, headed by Sir Clement Price Thomas, and tours of Prof. C. Wells to Pakistan, Burma, Thailand, the Philippines, Australia and Canada, to advise on surgical techniques and radiological services, and of Sir Alister Hardy to Pakistan, Thailand, Hong Kong and Japan to inspect oceanographic institutions. More than 1,800 visits of scientific specialists to and from Britain were assisted by the Council in one way or another in 1957–58, representing 35 per cent of the total for all subjects and professions. In numbers this represents 42·6 per cent out of 4,902 visitors to the United Kingdom under the auspices of the Council, compared with 18·5 per cent in social studies, 14·8 per cent in education and 10·1 per cent in medicine; for 1951, the corresponding figures were 23·5, 15, 14·5 and 10 per cent, respectively. There has been a striking growth in recent years of the Council's responsibilities as agents for the United Nations Specialized Agencies, the Colombo Plan, the Baghdad Pact and other international agencies offering training in the United Kingdom, and in 1957–58 1,012 such visitors were cared for in the United Kingdom by the Council, compared with 191 in 1950–51. About £380,000 a year is administered by the Council for international and overseas organizations.

The fifteen short specialist courses arranged annually included one on the economic problems of developing countries, for senior officials and administrators, and in 1957 study tours were arranged for 67 groups, many from British Colonial territories, while in the autumn of 1957, 300 Soviet students and young people were invited to visit the United Kingdom for periods of three weeks. This programme has made considerable progress on an exchange basis with the co-operation of leading student and youth organizations in the United Kingdom, while the Council has also placed a number of postgraduate Soviet scholars in British universities and promoted exchange visits of teachers of English and Russian to summer schools in the United Kingdom and the U.S.S.R.

The number of overseas students in the United Kingdom rose in 1957 to 35,000 and is now about 38,000, less than a third of whom are at universities. In 1957, 7,782 students were met on arrival, 4,644 were assisted to find permanent accommodation, 386 becoming permanent residents in the Council's own residences, which also provided transit accommodation for 1,692 students. New premises were acquired during 1957–58 in Hull, Leeds, Liverpool and Nottingham. Some 13,259 overseas students attended British Council vacation and week-end courses and study visits, and private hospitality was arranged for 5,481 students. Travel grants to university teachers on study leave and to postgraduate workers totalled thirty-six (twelve from Australia) for visits to the United Kingdom and four for visits from the United Kingdom, and under the younger research workers interchange scheme twelve visited the United Kingdom and twenty-five from the United Kingdom visited six European countries.

* British Council. Annual Report 1957–1958. Pp. vi+111+8 plates. (London: British Council, 1958.)

COSMOGENIC NOBLE GASES IN THE WASHINGTON COUNTY METEORITE

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AN iron meteorite, designated the Washington County or Arickaree meteorite, was discovered in a Colorado wheat field in 1927. Eugene King, the finder, seemed to observe evidence of heat in the soil in which it was embedded, and as in addition almost no evidence of rusting is observed, it would appear that the meteorite fell recently. A proposed date of fall is 1916 [1]. It contains 9·3 per cent nickel[1] and does not show a Widmanstätten pattern; it is thus classified as a nickel-rich ataxite. In this experiment, pieces of the meteorite, supplied to us by the Harvard Museum through the courtesy of Dr. E. L. Fireman, of the Smithsonian Astrophysical Laboratory of the Harvard Observatory, were examined by mass spectroscopy to determine if noble gases, originating from spallation effects induced by cosmic rays, were present.

There has been discussion as to whether the Washington County meteorite is indeed a meteorite, or whether it might be an example of terrestrial iron. The overall appearance of the slab as found was similar to what might be expected of machined iron, as if it might have been discarded from a cast. In addition, voids were observed distributed throughout the mass, in contrast to other known meteorites. The presence of helium-3 was discovered in the present experiment, thus establishing definitely that the metal was exposed to extra-terrestrial cosmic radiation, and is, in fact, a meteorite.

Samples weighing 0·1–0·2 gm. were melted in a graphite crucible at a temperature of approximately 2,000° C. by means of an induction heater. The entire gas line leading from the sample to the mass spectrometer, including the samples of standard gas, were maintained in vacuum at pressures not above 10^{-6} mm. of mercury. The line was constructed of 'Pyrex' glass, formula 1720, which effectively inhibits the diffusion of helium through the walls.

After melting, the escaped gases were purified by passing them over copper oxide and calcium heated to 600° C. They were then introduced into the mass spectrometer and the helium-3, helium-4, argon-36 and argon-38 were quantitatively determined. The argon was then adsorbed on charcoal at liquid-nitrogen temperatures, and the neon isotopes 20, 21 and 22 were measured. Standard amounts of the above gases were added to the sample in the mass spectrometer and the equipment was thus calibrated. Blank determinations were run at the specified crucible temperature before each sample. A blank was run after each sample at a crucible temperature approximately 50° higher. This blank was found to contain approximately 3–5 per cent of the noble gases, indicating that each sample was well outgassed. This amount was then added to the results originally obtained.

It is expected that the results obtained for all isotopes except neon-20 are good to within 10 per cent. The value for neon-20 could not be determined so accurately because of background due to doubly charged argon-40, and it is felt that the true value may vary from that given by up to a factor of 2. No number is reported for the abundance of argon-40 in the meteorite because of this large background of atmospheric argon. The correction that was applied to the argon-36, however, was only 10–20 per cent of the peak value, and that applied to argon-38 was less than 5 per cent. The accuracy of the mass spectrometer was tested by bombarding a gold target with α-particles in the Brookhaven cyclotron, the incident intensity being measured with a Faraday cup[2]. The target was melted in the mass spectrometer and the helium-4 was measured. The results agreed with those measured by the Faraday cup to within 5 per cent. The measured results are shown in Table 1.

Table 1

Sample No.	Abundance in units of 10^{-8} c.c./gm. He-3	He-4	Ne-20	Ne-21	Ne-22	Ar-36	Ar-38
	193	2,700	8	2·14	2·6	5·6	7·8
II	193	3,100	5	1·98	2·2	5·1	7·2
Average	193	2,900	7	2·06	2·4	5·4	7·5

A comparison with other meteorite data can most profitably be made on the basis of rare-gas ratios reported for iron meteorites with high (of the order of 10^{-6} c.c./gm.) helium-3 contents. For example, for the ratio helium-3/neon-21, values are reported ranging from 72 to 130. Our value is 94, in the range of these previous numbers. For the ratio helium-3/argon-38, values are reported[3,4] in the interval 15–40. Our value is 26.

The ratio helium-4/helium-3, however, is approximately five times that previously found for comparable meteorites.

The early experimenters on noble gases in meteorites attributed the helium-4 content to uranium and thorium disintegrations[5], and, on the basis of measured helium-4 and uranium–thorium contents, they determined ages for the meteorites. No general consistency was found in the ages determined for various meteorites by this method. Since these early experiments, two objections to the technique have been raised. From measured amounts of other noble gases in meteorites[6], it is now thought that practically all the helium-4 is, in fact, due to spallation effects from nuclear reactions induced in the meteorite by high-energy cosmic rays[7]. The other objection, raised by Urey[8], is that the dates may be in error due to the diffusion of radiogenic helium along crystal structure boundaries, an argument being advanced that the majority of the uranium will segregate itself along these boundaries. Reed and Turkevich[9] have measured the uranium content of two iron meteorites by neutron activation and have set an upper limit of 10^{-10} gm./gm.—an amount insufficient to account for the helium-4 actually found in meteorites.

In the present experiment the high value for the ratio helium-4/helium-3 may indicate that a considerable portion of the helium-4 is in this case radiogenic. It would thus be possible to estimate the cosmogenic helium-4 content by the measured helium-3 content and the known value of this ratio in other iron meteorites. We have assumed a

helium-3/helium-4 ratio of 0·25, natural abundance of uranium-235 and uranium-238 in the meteorite, a thorium-232/uranium-238 ratio of 4, and an age of 10×10^9 years[10], and have thus estimated the uranium-238 content of this meteorite to be 3×10^{-10} gm./gm. An age of 5×10^9 years changes this estimate to 1×10^{-8} gm./gm. These values are well within the sensitivity of the neutron activation method of analysis[11] and show a significant variation at the two estimated ages. Accordingly, an attempt will be made in this laboratory to measure the uranium content by this method and possibly obtain a helium–uranium date for the meteorite. The grain boundaries along which the helium might leak out are absent to a large extent in the ataxite structure, and this objection should be greatly reduced.

The argon-36/argon-38 ratio has been measured in other iron meteorites[3,4] and usually found to be 1·6. The value found here for the Washington County meteorite is 1·4. This may be due to the high nickel content, spallation reactions from the predominant nickel-58 isotope perhaps favouring the formation of argon-36; on the other hand, the difference between these values may not be significant.

We wish to express our appreciation for the technical assistance of Mr. J. Densieki and for several valuable discussions with Dr. E. L. Fireman.

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[1] Palache, C., and Shannon, E. V., *Amer. Min.*, **13**, 406 (1928).
[2] Amiel, S., and Porile, N. T., *Rev. Sci. Instr.* (in the press).
[3] Vinogradov, A. P., Zadorozhnyi, I. K., and Florenskii, K. P., *Geokhimiya*, 443, No. 6 (1957). Schaeffer, O. A. (unpublished results).
[4] Gentner, W., and Zähringer, J., *Z. Naturforsch.*, **10** *a*, 498 (1955).
[5] Arrol, W. J. Jacobi, R. B., and Paneth, F. A., *Nature*, **149**, 235 (1942).
[6] Paneth, F. A., Reasbeck, P., and Mayne, K. I., *Geochim. Cosmochim. Acta*, **2**, 300 (1952); *Nature*, **172**, 200 (1953). Dalton, J. C., Paneth, F. A., Reasbeck, P., Thomson, S. J., and Mayne, K. I., *Nature*, **172**, 1168 (1953).
[7] Bauer, C. A., *Phys. Rev.*, **72**, 354 (1947). Hartley, H. E., *Nature*, **161**, 356 (1948).
[8] Urey, H. C., *Nature*, **175**, 321 (1955).
[9] Reed, G. W., and Turkevich, A., *Nature*, **176**, 794 (1953).
[10] Stoenner, R. W., and Zähringer, J., *Geochim. Cosmochim. Acta* (in the press).
[11] Reed, G. W., Hamaguchi, H., and Turkevich, A., *Geochim. Cosmochim. Acta*, **13**, 248 (1958).

ABSORPTION SPECTRUM AND DECAY KINETICS OF THE METASTABLE STATE OF CHLOROPHYLL *b*

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As part of an extensive investigation of the photochemistry of chlorophyll we have studied the absorption spectrum and decay scheme of the metastable state of chlorophyll *b* in benzene solutions free from oxygen. As some related work in this field has recently been reported[1,2], a short presentation of some of our results may be of interest.

Using the flash photolysis and flash spectroscopy technique[3], the absorption spectrum of the metastable state was determined from 290 up to 840 mμ from measurements during the exciting flash. The red or blue part of the emission spectrum from the flash lamp was isolated for excitation. With the high-energy flash (that is, 400 μF. at 5 kV., and a 60 μsec. duration) at our disposal[4], it was possible to achieve complete conversion to the metastable state. The total absence of chlorophyll *b* in the ground-state increased the accuracy of the absorption spectrum measurements, especially in the region of the absorption peaks of the ground-state.

The optical arrangement was such that no detectable stray light from the exciting flash entered the recording system. Each photographic plate was individually calibrated by a set of seven grey filters.

The concentration of chlorophyll *b* in the benzene solutions was $0{\cdot}35 \times 10^{-6}$ *M*, and the length of the optical path was 60 cm. At such a length the absorption of oxygen-containing benzene is appreciable up to 350 mμ, therefore the solvent for the blank spectra had to be carefully degassed.

Fig. 1 indicates the absorption spectrum of the metastable state, as obtained from three independent sets of experiments. The ultra-violet region was obtained from a series of 3 plates, 7 spectra; the visible region from 8 plates, 14 spectra; and the infra-red region from 5 plates, 7 spectra. As is seen, the absorption curves from these three wave-length regions tie together in a very satisfactory manner without any corrections. The points obtained from the flash experiments, corresponding to the ground-state of

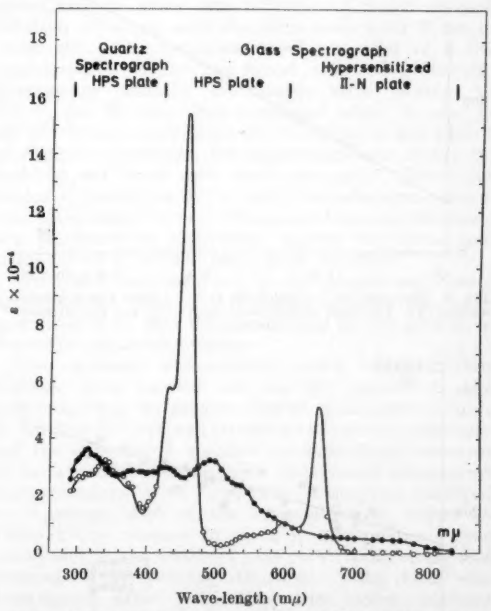

Fig. 1. The absorption spectra of chlorophyll *b* in benzene in its ground-state (○) and in its metastable state (●). The points were obtained photographically from flash experiments, while the solid curve for the ground-state was determined spectrophotometrically. The types of plates used for the different wave-length regions are indicated

chlorophyll *b*, fit very closely to the absorption curve as determined by standard spectrophotometry. These points were corrected for an excitation of 5 per cent caused by the spectrograph flash lamp, this having been established in separate experiments.

The spectrum in Fig. 1 was obtained using only red light for the excitation of the chlorophyll *b*, yet some spectra were also recorded using blue light. The absorption spectra obtained in each case were identical.

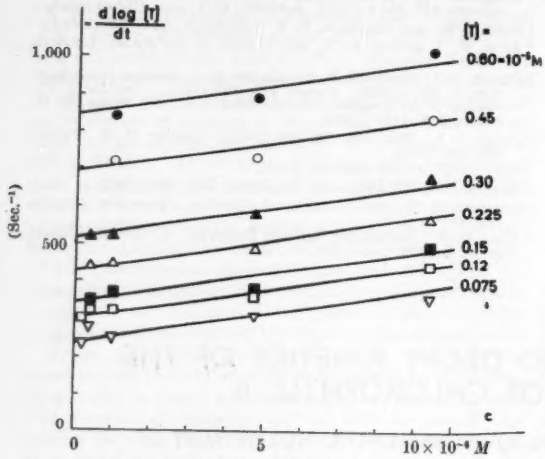

Fig. 2. The extrapolation of $-\mathrm{d}\log(T)/\mathrm{d}t$ to $c = 0$. The slope gives the value of k_3

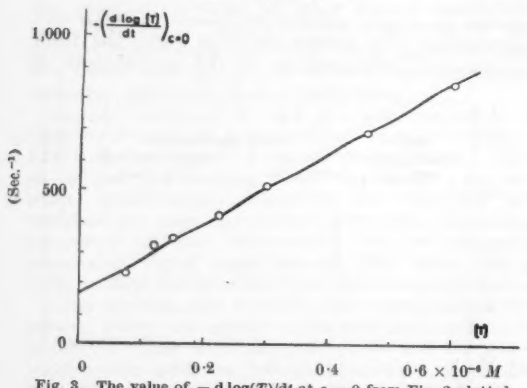

Fig. 3. The value of $-\mathrm{d}\log(T)/\mathrm{d}t$ at $c = 0$ from Fig. 2 plotted against (T). The slope of the line gives $k_3 - k_2$, and the intercept gives k_1

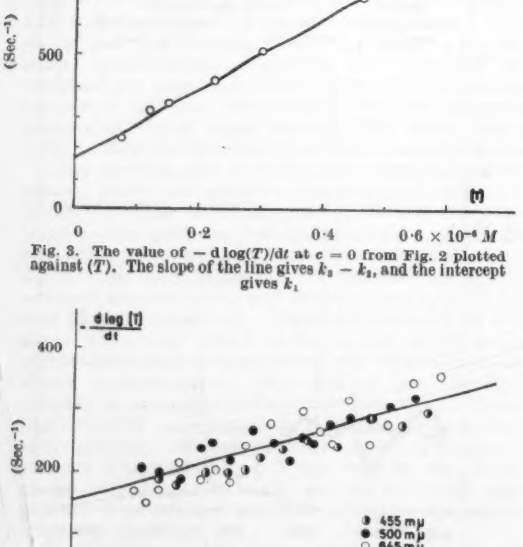

Fig. 4. The decay of the metastable state, as measured at three different wave-lengths, where the total concentration of chlorophyll *b* was $0{\cdot}2 \times 10^{-6}$ *M*

The kinetic measurements were carried out over the concentration range of 10^{-7} to 10^{-5} *M*, with optical path-lengths of 60 and 20 cm. The transient decay was studied both photographically and photoelectrically, principally the latter.

For all wave-lengths studied (that is, 410–645 mμ) the decay was in agreement with a scheme proposed by Livingston[5]. It may be represented as follows, where T indicates the metastable state and S the ground-state of chlorophyll *b*:

$$T \rightarrow S \quad (1)$$

$$T + S \rightarrow S + S \quad (2)$$

$$T + T \rightarrow S + S \quad (3)$$

Then, if the total concentration of chlorophyll *b*, $(T) + (S)$, is denoted by c,

$$-\frac{\mathrm{d}(T)}{\mathrm{d}t} = k_1(T) + k_2(T)(S) + k_3(T)^2 \quad (4)$$

$$-\frac{\mathrm{d}\ln(T)}{\mathrm{d}t} = k_1 + k_2 c + (k_3 - k_2)(T) \quad (5)$$

For the determination of the three constants in equation (5), we have relied chiefly on values obtained at 500 mμ. Extrapolations to $(T) = 0$ and $c = 0$ are needed, these being carried out in either order. Figs. 2 and 3 illustrate one of these possibilities. For each total concentration the decay-rate is determined at some selected values of the concentration (T) of the metastable state. For each (T), an extrapolation to $c = 0$ is performed (Fig. 2) to give $(\mathrm{d}\log(T)/\mathrm{d}t)_{c=0}$, the slope defining the constant k_3. The ordinates for $c = 0$ are plotted in Fig. 3 against (T), the intercept giving k_1 and the slope giving $k_3 - k_2$. Each point in Fig. 2 is based on two or three different experiments consisting of 10–30 oscillograms. The results for the three constants are:

$$k_1 = 0{\cdot}4_0 \times 10^3 \text{ sec.}^{-1}$$

$$k_2 = 0{\cdot}03_5 \times 10^9 \text{ sec.}^{-1}\ M^{-1}$$

$$k_3 = 2{\cdot}3_5 \times 10^9 \text{ sec.}^{-1}\ M^{-1}$$

In connexion with the determination of the absorption spectrum of the metastable state shown in Fig. 1, kinetic experiments were also performed photographically, these revealing four isosbestic wave-lengths. During the photoelectrical measurements of the kinetics, two of these wave-lengths, 418 and 474 mμ, were further confirmed. No change in extinction at these two wave-lengths was observed. From this it is concluded that only one metastable state is present under these experimental conditions. A further proof is the good agreement among the decay rates for different wave-lengths. This is illustrated in Fig. 4, where the same kinetics is obtained at the three wave-lengths shown.

The chlorophyll *b* was prepared by Zscheile and Comar's method[6]. A small amount of water was purposely left in the stock solution, thus avoiding difficulties in interpretation due to superdryness of the final solutions. The solutions were degassed by five cycles of freezing, evacuating and melting.

A detailed account of this work will appear in the near future.

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[1] Fujimori, E., and Livingston, R., *Nature*, **180**, 1036 (1957).
[2] Linschitz, H., and Sarkanen, K., *J. Amer. Chem. Soc.*, **80**, 4826 (1958).
[3] Norrish, R. G. W., and Porter, G., *Nature*, **164**, 658 (1949).
[4] Claesson, S., and Lindqvist, L., *Arkiv Kemi*, **11**, 535 (1957).
[5] Livingston, R., *J. Amer. Chem. Soc.*, **77**, 2179 (1955).
[6] Zscheile, F. P., and Comar, C. L., *Bot. Gaz.*, **102**, 463 (1941).

IN VITRO ANALYSIS OF A MAMMALIAN TUMOUR VIRUS

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THE classical studies of Ellerman and Bang[1] and Rous[2] first demonstrated that viruses could be involved in the origin of neoplastic growth. Several tumour viruses have now been isolated from birds and frogs, and in mammals viruses are known to be associated with papilloma in rabbits and some other species, fibroma in rabbits, and mammary tumours in mice[3]. In 1951, Gross[4] reported his original observations on the viral origin of a spontaneous lymphatic leukæmia in mice. This observation has been fully confirmed[5], and since then viruses have been found to be associated with some other types of leukæmia[6], parotid tumours and sarcomas[7] and various other neoplasms in mice and hamsters[8]. All these observations in mammals, with the exception of those of Stewart *et al.*[8], have been made after inoculation of filtrates from a tumour directly into a susceptible host. It seems clear that even for the actual isolation of viruses such a procedure has limitations; and such studies, by themselves, can, of course, give little direct information on cell virus relationships. It would appear that an answer to the basic questions relating to tumour viruses in mammals can only be given by combining an *in vivo* with an *in vitro* analysis.

It has been shown by Stewart *et al.*[8] that a virus originating from a spontaneous lymphatic mouse leukæmia can be maintained in tissue culture, and that when harvested from such cultures it can produce a variety of tumours. We are indebted to Drs. Stewart and Eddy for sending us some of their line 3919 of this virus, which they have termed polyoma virus, and the present report deals with some *in vitro* studies with this material.

The polyoma virus was routinely grown in Petri dishes on monolayers of Swiss mouse embryos, incubated in a humidified atmosphere containing 10 per cent carbon dioxide[9], using a medium of 0·5 per cent lactalbumin hydrolysate in Earle's saline and 20 per cent horse serum. Our first passage in culture of the material received from Stewart and Eddy gave a clear cytopathogenic effect, as a result of which cells become detached from the glass, often in grape-like clusters, and degenerate; and a cytopathogenic effect with this virus has also recently been reported by these authors[10]. In addition to embryo, cells of adult mouse kidney and bone marrow were tested and a cytopathogenic effect was produced in both these tissues. The demonstration of an observable effect on cells in culture has made it possible to develop a plaque assay for this virus similar to that originally developed for viruses such as poliomyelitis[9]. The cytopathogenic effect could be localized into foci under agar; the technique will be described in detail elsewhere. Plaques appeared as small discrete foci of degenerate cells. Isolations from plaques should give pure lines of virus and these are being tested for the type of tumours that they produce.

Table 1. Spectrum of Red Blood Cells agglutinated by Polyoma Virus

Red blood cells	Hæmagglutination titre 1 : Virus-infected t.c. fluid	Normal t.c. fluid	Red blood cells	Hæmagglutination titre 1 : Virus-infected t.c. fluid	Normal t.c. fluid
Guinea pig	2,048	8	Sheep	512	—
Rat	256	128	Goat	—	—
Mouse (Swiss)	1,024	64	Dog	1,024	4
Hamster	8	8	Cat	16	16
Frog (*Hyla arborea*)	4,096	16	Chick (1 day old)	1,024	8
Human (O)	128	8	Hen (adult)	2,048	—
Monkey (rhesus)	512	4	Turkey	2,048	8
(patas)	16	8	Pigeon	32	32
(baboon)	32	4	Goose	16	16
Horse	—	—	Duck (*Anas coxhas*)	16	16
Cow	—	—	(*Anas moscant*)	512	16

We have also found, as recently reported by Eddy *et al.*[10], that the polyoma virus can hæmagglutinate at refrigerator, but not at higher, temperatures. The spectrum of its agglutinability for red blood cells from different species is shown in Table 1. Guinea pig cells have been routinely used with titres up to 1 : 4,096. 0·15 c.c. of a 1 per cent suspension of red blood cells in saline was added to 0·5 c.c. of each dilution of virus, and the tests read after 3 hr. or overnight. The end-point used was that of a full agglutination of the red blood cells. The hæmagglutinating particles are stable after heating at 56° C. for 30 min., but destroyed after 30 min. at 66° C. When taken from the refrigerator and placed at room temperature, the agglutination is destroyed and the red blood cells settle normally. The virus is eluted readily at 37° C., and the cells after elution can again adsorb virus. Hæmagglutination inhibition was produced by antibodies against the virus, and titres up to 1 : 81,920 have been obtained.

With the establishment of the plaque and hæmagglutination assays, it became possible to make quantitative *in vitro* determinations on the growth of the virus in tissue culture.

Two separate experiments, using two different inocula, were carried out on the growth of the polyoma virus on mouse embryo monolayers (Table 2). In Exp. 1 there was no change of medium throughout the experiment so that the cumulative amount of virus could be determined. A series of monolayers were inoculated with virus (3 hr. absorption followed by washing), and at the time intervals shown in Table 2 the amount of virus in the medium (free virus) and in the medium plus cells (total virus) was determined by hæmagglutination. Total virus was determined after subjecting the entire cultures (medium plus cells) to five cycles of freeze thawing at − 20° C. In Exp. 2 a series of monolayers were inoculated as previously and the amount of virus released into the medium was determined during the first 24-hr. and two subsequent 48-hr. periods. After

Table 2. Growth of Polyoma Virus on Mouse Embryo Monolayers

			Days post-inoculation 1	3	5	7
Exp. 1 (cumulative)	'Total virus' by hæmagglutination assay*		8	256	256	256
	'Free virus' by hæmagglutination assay		8	32	32	64
Exp. 2 (virus after a 24-hr. and two 48-hr. periods)	'Free virus' (Series 1) by hæmagglutination assay	*A*	16	512	128	—
		B	16	512	128	—
		C	16	512	128	—
		D	16	1,024	128	—
	'Free virus' (Series 2) by hæmagglutination assay	*A*	8	512	128	—
		B	8	256	128	—
	'Free virus' (Series 2) by plaque assay†	*A*	11	234	114	—

* Hæmagglutination titres expressed as reciprocal of complete hæmagglutination end-point per 0·5 ml. Hæmagglutination titre of control plates was 8.

† Plaque assay expressed as mean number of plaques (4 plates) per 0·2 ml. at 1 : 10 dilution.

Exp. 1, strong cytopathogenic effect after 7 days. Exp. 2, strong cytopathogenic effect and complete destruction of monolayer after 5 days.

each collection date all the cultures were washed and fresh medium added. This experiment was carried out in two series. In series 1 the samples tested at day 1, 3 and 5 were taken from the same plate in each of the four replicates (*A–D*). In series 2, the samples tested at day 1, 3 and 5 in the two replicates (*A* and *B*) were taken from different plates. The virus in series 1 was assayed by hæmagglutination and in series 2 by hæmagglutination and plaques. In all experiments the virus assayed by hæmagglutination was from supernatants after centrifugation at 3,000 r.p.m. in a clinical centrifuge for 10 min.

The results of both experiments clearly show that there has been multiplication of the virus on mouse embryo cultures, and that virus is released over a long period of time. Little or no virus could be detected during the first 24 hr., and the highest level of virus production and release in Exp. 2 was during the period between the first and third day. The drop in virus during the next 48-hr. period in this experiment may have been due to the early appearance of a strong cytopathogenic effect. It can also be seen from Exp. 2 that the results obtained from plaques follow that obtained by hæmagglutination. The results of Exp. 1 show that the free virus was less than the total virus throughout the experiment, indicating that a significant amount of virus produced remains associated with cells and is not released immediately into the medium. A similar situation has been noted in viruses such as vaccinia and sheep pox[11]. The behaviour of the polyoma seems to differ in some respects from that reported for the Rous chicken virus[12].

These results with the polyoma demonstrate that with the use of the plaque assay developed it is now possible to produce pure lines of mammalian tumour virus, and that furthermore it is now possible to use *in vitro* techniques both for the characterization of mammalian tumour viruses and for the analysis of cell virus relationships.

[1] Ellerman, V., and Bang, O., *Zentr. Bakteriol. Parasitenk.*, I, *Orig.*, **46**, 595 (1908).

[2] Rous, P., *J. Exp. Med.*, **13**, 397 (1911).

[3] See Oberling, C., and Guerin, M., "Adv. Cancer Res.", **2**, 353 (1954).

[4] Gross, L., *Proc. Soc. Exp. Biol. Med.*, **76**, 27 (1951).

[5] Woolley, G. W., and Small, M. C., *Cancer*, **9**, 1102 (1956). Furth, J., Buffett, R. A., Banasiewicz-Rodriguez, M., and Upton, A. C., *Proc. Soc. Exp. Biol. Med.*, **93**, 165 (1956). Dulaney, A. D., Maxey, M., Schillig, M. G., and Goss, M. F., *Cancer Res.*, **17**, 809 (1957). Hays, E. F., and Beck, W. S., *Cancer Res.*, **18**, 676 (1958).

[6] Graffi, A., Bielka, H., and Fey, F., *Acta Haemat.*, **15**, 145 (1956). Friend, C., *J. Exp. Med.*, **105**, 307 (1957). Schoolman, H. M., Spurrier, W., Schwartz, S. O., and Szanto, P. B., *Blood*, **12**, 694 (1957).

[7] Gross, L., *Proc. Soc. Exp. Biol. Med.*, **83**, 414 (1953); **88**, 362 (1955). Stewart, S. E., *J. Nat. Cancer Inst.*, **15**, 1391 (1955).

[8] Stewart, S. E., Eddy, B. E., Gochenour, A. M., Borgese, N. G., and Grubbs, G. E., *Virology*, **3**, 380 (1957). Stewart, S. E., Eddy, B. E., Borgese, N., *J. Nat. Cancer Inst.*, **20**, 1223 (1958). Eddy, B. E., Stewart, S. E., Young, R., and Mider, G. B., *J. Nat. Cancer Inst.*, **20**, 747 (1958).

[9] Dulbecco, R., and Vogt, M., *J. Exp. Med.*, **99**, 167 (1954).

[10] Eddy, B. E., Stewart, S. E., and Berkeley, W., *Proc. Soc. Exp. Biol. Med.*, **98**, 848 (1958). Eddy, B. E., Rowe, W. P., Hartley, J. W., Stewart, S. E., and Huebner, R. J., *Virology*, **6**, 290 (1958).

[11] Overman, J. R., and Tamm, I., *Virology*, **3**, 173 (1957). Plowright, W., and Ferris, R. D., *Brit. J. Exp. Path.*, **39**, 424 (1958).

[12] Rubin, H., *Virology*, **1**, 445 (1955).

AGGREGATION OF COD MYOSIN DURING FROZEN STORAGE

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MONODISPERSE cod myosin has a pronounced tendency to aggregate when neutral solutions of it are left undisturbed at 0° C.[1,2]. The aggregation is characterized by the appearance in the ultracentrifuge picture of the solution of at least one, and sometimes two, discrete components which sediment faster than myosin and which, on the basis of their sedimentation coefficients, can be identified as a side-to-side dimer and trimer, respectively. It has now been found that this aggregation proceeds in the frozen state.

Solutions of monodisperse cod myosin (0·4–0·6 per cent) in 0·45μ potassium chloride with 0·05μ phosphate buffer, *p*H 7·5, contained in $\frac{5}{8}$ in. × 2 in. thin-walled plastic tubes, were frozen by immersion in a bath of chloroform-solid carbon dioxide at about −78° and then stored for 3 or 4 days at −7, −14, −22, −29 and −78°. They were then thawed by placing the tubes in ice water so that the final temperatures never rose above 0°. Figs. 1 (*d–h*) show the ultracentrifuge pictures obtained immediately after the solutions were thawed. Fig. 1 also shows pictures of the original solution and the original solution after standing 3 days unfrozen at 0°. It is evident that (omitting Fig. 1*b*) least aggregation has occurred in the unfrozen solution kept at 0° and in the solution kept at −29° for 4 days, the amount of monomeric myosin in these solutions being still so great that the top of the schlieren peak is not registered and the typical bar effect parallel to the meniscus is produced. Most aggregation has occurred in the solution kept at −14° and −22°, most of the myosin having formed heavy polydisperse material which has sedimented to the bottom of the cell before the photographs were taken, leaving small residual amounts of monomeric and oligomeric myosin in the supernatant solution.

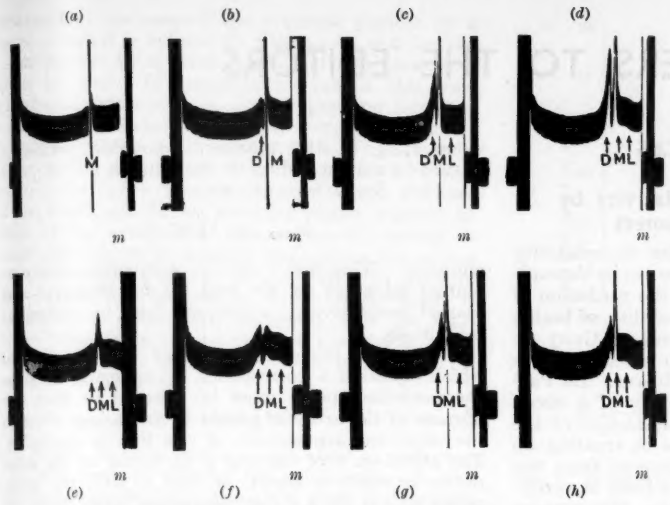

Fig. 1. Sedimentation pictures of cod myosin solutions. *a*, original solution; *b*, *a* frozen to −78° and thawed at 0° five times in succession; *c*, *a* left unfrozen at 0° for 3 days; *d*, *e* and *f*, *a* frozen to −78°, stored for 3 days at −7, −14 and −20°, respectively, then thawed at 0°; *g* and *h*, *a* frozen to −78°, stored for 4 days at −29 and −78°, then thawed at 0°. Sedimentation at 59,780 r.p.m. occurs from right to left. *m* is the meniscus; *D*, *M* and *L* denote, respectively, dimeric and monomeric myosin and a light component. Exposures taken: *a*, 96; *b*, 75; *c*, *d*, *e*, *g* and *h*, 69; and *f*, 53 min. after reaching full speed. Temperature of rotor: *a*, 2·20; *b*, 4·70; *c*, 1·95; *d*, 4·40; *e*, 5·30; *f*, 7·15; *g*, 2·25; and *h*, 3·65° C.

At −7° and −78° aggregation has proceeded to some intermediate stage.

This result has been confirmed with two other different preparations of cod myosin. Solutions kept frozen for about 7 days and then thawed, particularly those at −14° and −22°, often contain blobs of weak transparent gel and fine precipitates. The operation of freezing and thawing even when carried out five times in succession on the same solution produces only traces of material which sediments faster than myosin (Fig. 1*b*).

Two experiments with myosin frozen in solutions containing 0·45μ sodium chloride and 0·45μ potassium sulphate (both with 0·05μ phosphate buffer, *p*H 7·5) showed that the pattern of aggregation is different from that in solutions containing potassium chloride. In solutions containing 0·45μ sodium chloride aggregation is much the same at −7, −14 and −22° but less at −29 and −78° than at the higher temperatures; in solutions containing 0·45μ potassium sulphate aggregation is pronounced at −7° and becomes progressively less at the lower temperatures. These observations suggest that both the eutectic temperature of the solution (about −1·5, −11 and −21° for potassium sulphate, potassium chloride and sodium chloride, respectively) and the temperature of storage are important factors in determining the rate of aggregation. Snow[3] has suggested that the rate of insolubilization of haddock actomyosin during frozen storage of its solutions is greatest at temperatures below the eutectic point.

Fig. 1 also shows that a component (*L*), which sediments more slowly than myosin, is formed during frozen storage and possibly also during equivalent periods of storage in the unfrozen state at 0°. The largest amount of this presumed dissociation sub-unit of myosin appears to be produced at −78°.

The mechanism of these complex changes is unknown; but they occur without any appreciable intramolecular change because the specific rotation and numbers of sulphydryl groups titratable with N-ethylmaleimide do not change during the first 7 days storage at −7°, for example. It has been noted also that the aggregation of cod myosin in the unfrozen state at 0° apparently does not proceed by a conversion of sulphydryl groups into disulphide bridges because (1) the aggregation is not inhibited by the addition of 0·01 *M* monothiglycol, and (2) myosin the reactive sulphydryl groups of which have been blocked by N-ethylmaleimide aggregates just as rapidly as untreated myosin.

Further aspects of these changes are being investigated, particularly in relation to the toughness and loss of water-holding capacity which develop during the frozen storage of fish muscle. The development of toughness in stored fish must ultimately involve some sort of intermolecular cross-linking or aggregation reaction of the proteins. The changes occurring during the frozen storage of whole muscle have been often ascribed to protein 'denaturation'[4–9], the implication being that some form of unfolding or configurational alteration of the molecules occurs. However, the experiments described here suggest that some part, or the whole, of these changes may involve aggregation of native configurationally unchanged molecules. This notion is supported by a number of scattered observations. Thus, no change in the numbers of sulphydryl groups of that part of the fish actomyosin complex which remains soluble after frozen storage could be found[7,10]. (In one investigation[6], apparently random variations in the 'masked' sulphydryl groups of whole fish muscle during frozen storage did occur in some circumstances.) In addition, the apyrase activity of whole fish muscle does not decline during conditions of frozen storage which undoubtedly lead to the development of toughness of the tissue and insolubility of the myofibrillar proteins[11]. Partmann's suggestion[11] that the explanation for this phenomena lies in the fact that the *H*-meromyosin sub-unit, which possesses all the adenosine triphosphase activity of the myosin, is reported[12] to be unaffected by freezing while *L*-meromyosin is rendered insoluble, remains to be investigated.

This work was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

1 Connell, J. J., *Biochem. J.*, **69**, 5 (1958).
2 Connell, J. J., *Biochem. J.*, **70**, 81 (1958).
3 Snow, J. M., *J. Fish Res. Bd. Can.*, **7**, 599 (1950).
4 Dyer, W. J., *Food Res.*, **16**, 522 (1951).
5 Dyer, W. J., Proc. Symp. on Cured and Frozen Fish Technology, Göteborg, Paper No. 7 (1953).
6 Husaini, S. A., and Alm, F., *Food Res.*, **20**, 264 (1955).
7 Seagram, H. L., *Food Res.*, **21**, 505 (1956).
8 Luijpen, A. F. M. G., *Nature*, **180**, 1422 (1957).
9 Love, R. M., *J. Sci. Food Agric.*, **9**, 597, 604, 609 (1958).
10 Duerr, J. D., and Dyer, W. J., *J. Fish Res. Bd. Can.*, **8**, 325 (1952).
11 Partmann, W., *Z. LebensmittUntersuch.*, **99**, 341 (1954).
12 Szent-Györgyi, A. G., *Arch. Biochem. Biophys.*, **42**, 305 (1953).

LETTERS TO THE EDITORS

PHYSICAL SCIENCES

Verification of General Relativity by means of Artificial Planets

The evidence from observation[1] for the relativity advance of the perihelia of planetary orbits depends primarily on the rate of advance of the perihelion of Mercury. I have discussed[2] the possibility of basing a verification of this result of general relativity on the motion of minor planets of high eccentricity, in particular on the motion of (1566) Icarus. La Paz[3] has pointed out the further possibility of a check based on observation of an artificial satellite of the Earth. The recent Russian success in creating an artificial planet of the Sun has removed from the realm of speculation the use of such a body in verifying the predictions of general relativity. The purpose of this communication is to show that the controllable orbit of an artificial planet can be selected to yield a very large relativity advance of perihelion under certain conditions.

The expression of general relativity for the angular advance ε (in radians) of a planetary perihelion per revolution is:

$$\varepsilon = 6\pi GM\,[c^2 a\,(1 - e^2)\,]^{-1} \qquad (1)$$

where a is the semi-major axis and e the eccentricity of the orbit, M is the mass of the Sun, G is the gravitational constant, and c is the speed of light. It will be assumed that propulsion of the artificial planet terminated in the immediate neighbourhood of the Earth. Hence, the minimum possible value of a is approximately $\frac{1}{2}$ A.U. (corresponding to $e \sim 1$), fixed by the fact that the aphelion point cannot lie inside the Earth's orbit. As in the corresponding case for a minor planet[2], it follows that a significantly large relativity advance for an artificial planet is possible only for large eccentricity.

When the approximation $e \sim 1$ is made, equation 1 can be written in the form:

$$\varepsilon = (3\pi GM/c^2)q^{-1} \qquad (2)$$

where $q = a\,(1 - e)$ is the perihelion distance of the planet's orbit from the Sun's centre. For the case in question, equation 2 states that the relativity advance per revolution depends only on the reciprocal of the perihelion distance. If the semi-major axis a is measured in astronomical units, the annual advance v (in radians) of the perihelion is:

$$v = \varepsilon/a^{3/2} \qquad (3)$$

since in this case the period P in years is given by $P = a^{3/2}$. In the same units, one must have:

$$2a - q \geqslant 1 \qquad (4)$$

if the aphelion point is not within the Earth's orbit. The minimum possible value of q in equation 2 clearly is fixed by $q = R_\odot$, where $R_\odot$ is the solar radius. The corresponding point of tangency of the orbit with the Sun's surface at perihelion is the only point of contact, since the semi-parameter (half the latus rectum) given by $p = a\,(1 - e^2)$ always exceeds the perihelion distance q for an elliptical orbit. The value $v_{max.}$ of the maximum possible perihelion advance v corresponding to the minima $q = R_\odot$ and $a = (1 + R_\odot)/2$ from (4) is:

$$v_{max.} = 11{\cdot}6'' \qquad (5)$$

annually. This figure can be compared with centennial advances of 43″ and 10″ for Mercury[1] and Icarus[2] respectively, which are less by orders of magnitude.

In practice, the grazing contact with the Sun to which equation 5 corresponds is undesirable, since the perihelion point must be selected so that loss of mass of the artificial planet in its passage through the extended atmosphere of the Sun is negligible. The effect on v of varying q (in terms of the solar radius as unit) is shown in Fig. 1, with the semi-major axis a (in A.U.) as parameter, over limits set by inequality 4. One sees that a reasonable range of q and a exists over which the perihelion advance v of the artificial planet exceeds that of Mercury. In the latter case, the value of v is shown in Fig. 1 as a function of q, although the approximation $e \sim 1$ is inapplicable (v is large because a is small). In common with the principal planets of mean distance greater than that of Mercury, the Russian artificial planet does not meet the condition of high eccentricity for a significant relativity advance. The pertinent elements of its orbit are $e = 0{\cdot}148$ and $a = 1{\cdot}16$ A.U., as reported in the current Press[4]. From equation 1, the corresponding relativity advance of perihelion is $v = 2{\cdot}7''$ per century, which is less than the figure ($3{\cdot}8''$) for the Earth.

As is true also for the natural planets, the possibility of basing an observational test of the relativity formula 1 on the motion of an artificial planet depends on the possible precision in the measurement of the perihelion motion, as well as on the magnitude of the relativity advance. This precision can be

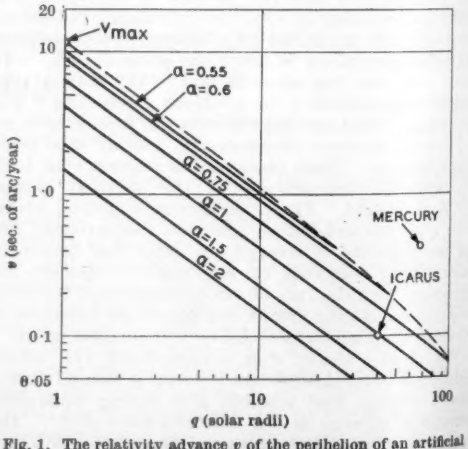

Fig. 1. The relativity advance v of the perihelion of an artificial planet of high eccentricity, as a function of its perihelion distance q (in units of the solar radius) from the Sun's centre, with the semi-major axis a (in astronomical units) as parameter. The dashed line corresponds to inequality (4). Values for Mercury and Icarus are shown for comparison. Scales are logarithmic

measured in the case of the principal planets by a figure of merit α defined by Clemence[1], and for the minor planets by a generalization of this parameter given by me[2]. It seems premature at this time to attempt evaluation of a corresponding figure of merit for an artificial planet. However, one important consideration associated with the factor l (the fraction of the period over which observations can be made) entering the figure of merit α can be noted. Because of the small size of an artificial planet relative to those of the observable minor planets, optical or radar observation is possible only when the object is in the immediate vicinity of the Earth. To optimize the number of passages in which observation is possible, it is accordingly necessary that the ratio of the planet's period to that of the Earth equal closely a ratio of small integers n and m. This condition requires that:

$$a \sim (n/m)^{2/3} \qquad (6)$$

for a in A.U. In time, of course, the effect of perturbations will tend to destroy the relationship 6, and this circumstance may ultimately limit the amount of data obtainable from an artificial planet, and the corresponding precision in fixing the relativity advance.

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[1] Clemence, G. M., *Rev. Mod. Phys.*, **19**, 361 (1947); *Proc. Amer. Phil. Soc.*, **93**, 532 (1949).
[2] Gilvarry, J. J., *Phys. Rev.*, **89**, 1046 (1953); *Pub. Astro. Soc. Pacific*, **65**, 173 (1953).
[3] La Paz, L., *Pub. Astro. Soc. Pacific*, **66**, 13 (1954).
[4] *New York Times* (Jan. 4, 1959).

Effect of Magnetic Activity on Drifts of the *F*2 Region

OBSERVATIONS of ionospheric drift made at high-latitude stations by different methods has been examined by several investigators with the view of studying the dependence of speed and direction of drift on magnetic activity. From such studies, it has generally been concluded that speeds of drift of the *F*2 region increase with increase of magnetic activity. As it was found[1] that drifts of the *F*2 region at Waltair show a significantly different behaviour from those at high latitudes, we have examined the results of the *F*2 drifts at Waltair with the view of ascertaining the nature and the extent of this dependence on magnetic activity.

For the purpose of the present analysis, observations made at Waltair (mag. lat. 9° 30′ N.) of drifts of the *F*2 region obtained by the spaced receiver method over a period of 16 months during February 1956 to May 1958 are utilized. The observations were made at 0900, 1200 and 1500 hr. I.S.T. on most of the days during this period. The operating frequency is adjusted in the range 5·8–6·2 Mc./sec., so as to obtain reflexions from an equivalent height of about 300 km. On some of the days for which 24-hourly observations are available, the mean of the three observations around these particular three hours is taken to give smoothed and representative values for these hours. As an index of magnetic activity, the magnetic K indices published by the Alibag

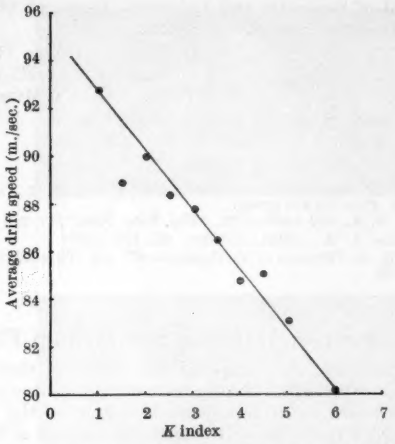

Fig. 1. Variation of speed of drift of the *F*2 region with geomagnetic K index

Magnetic Observatory are utilized for this study. At first the observations for all the three hours are grouped together and the speeds of drift corresponding to each value of K indices are sorted out and averaged. Fig. 1 shows a plot of the average speeds of drift thus obtained against the corresponding K indices. A total number of 466 observations were utilized for plotting this graph. A mean straight line drawn through all the points gives best fit, and reveals the interesting feature of decrease of mean drift speed of the *F*2 region with increase of magnetic activity in the range of 0–6, a result which is contrary to the exactly opposite conclusion drawn from high-latitude observations. A further interesting point is the more or less linear decrease of drift speed with magnetic K index. As the diurnal variation study of speed of drift at this station showed variations of speed of drift from hour to hour with maxima at noon and midnight, the results for each of the above three hours is also plotted separately against the K indices and the same trend of decrease of speed of drift with increase of K index is observed, the effect being, however, less for observations at 1500 hr.

Among the previous investigators, Briggs and Spencer[2] reported a progressive increase of speed of drift with K index for the range of values above 4, and Chapman[3] observed a linear variation of speed of drift with K index in the range of 1–4 and a more rapid variation above $K = 4$. The radio-astronomy results[4], on the other hand, indicated a more pronounced effect, and presumably these results refer to a height of 500 km. In the light of these earlier results, the present observations show an unusual behaviour which seems to be characteristic of low-latitude stations. In one respect, however, our results agree fairly well with the Cambridge results. Briggs and Spencer reported that the N.S. component is more or less unaffected by K index for the low range, while the E.W. component shows an increase on the western side. In the present investigation also, we noticed that the N.S. component remains more or less steady, while the E.W. component, which is towards west, decreases until it almost reaches very low values for high K indices.

A detailed account of this investigation will shortly be published elsewhere. We are indebted to the

Council of Scientific and Industrial Research (India) for supporting this investigation.

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[1] Rao, B. R., and Rao, E. B., *Nature*, **181**, 1612 (1958); *J. Atmo. Terr. Phys.* (in the press).
[2] Briggs, B. H., and Spencer, M., "Rep. Prog. Phys.", **17**, 245 (1954).
[3] Chapman, J. H., *Canad. J. Phys.*, **31**, 120 (1953).
[4] Maxwell, A., "Physics of the Ionosphere", 166 (Physical Society, (1955).

Bose–Einstein Statistics and Helium Films

Following the proposal of London[1] that the peculiar transition in liquid helium may be due to the accumulation of a significant fraction of the total number of particles in the ground-state of a Bose–Einstein gaseous assembly, many attempts have been made to understand the behaviour of this liquid in terms of the quantum statistics of a Bose gas. Most of these investigations have been confined to the study of helium in bulk. A few years ago, Osborne[2] applied Bose–Einstein statistics to helium films and showed that for films thicker than about 10^{-7} cm., the transition temperature should be the same as that for bulk liquid, whereas films thinner than this are effectively two-dimensional and should have transition temperatures much lower than the bulk value. The monotonic lowering of the 'onset' temperature of superfluidity with decreasing film thickness, observed in the study of unsaturated helium films[3] (which are essentially three-dimensional), thus remained unexplained[4].

Since it is to be expected that the properties of a statistical assembly would be modified when at least one of its dimensions becomes comparable with the mean de Broglie wave-length of the particles, we believe that a proper analysis based upon the Bose–Einstein statistics should be able to explain the observed phenomenon. In the present communication it is shown that such a study is possible provided the eigenfunctions in the bounded continuum are enumerated more exactly than is ordinarily done. We have therefore calculated the total number of particles in an ideal Bose–Einstein gaseous assembly by the equation:

$$N = \sum_i \frac{g_i}{\exp(\alpha + \varepsilon_i/kT) - 1} \qquad (1)$$

and while replacing the summation over states by an integral we use the expression[5]:

$$g(\varepsilon)\,\mathrm{d}\varepsilon = 2\pi V\left(\frac{2m}{h^2}\right)^{3/2}\varepsilon^{1/2}\left[1 + \frac{S}{8V}\left(\frac{h^2}{2m}\right)^{1/2}\frac{1}{\varepsilon^{1/2}}\right]\mathrm{d}\varepsilon \qquad (2)$$

We have taken periodic boundary conditions, and S/V is the ratio of the surface area of the enclosure to its volume.

Now, for the degenerate case ($\alpha = 0$) the integral over the correction term in (2) diverges. This is because we have replaced the summation by integration. On physical grounds we should expect that, to a crude approximation, the final result should not be much different from the one calculated from (2) if we replace $\varepsilon^{1/2}$ in the correction term by its average value:

$$\overline{\varepsilon^{1/2}} = (kT)^{1/2}\,[\Gamma 2\zeta(2)]/[\Gamma 3/2\zeta(3/2)]$$

whence one gets at the transition temperature T_0:

$$N = V\left(\frac{2\pi mkT_0}{h^2}\right)^{3/2}\zeta(3/2)\left[1 + \frac{0{\cdot}176\,S}{V}\left(\frac{h^2}{2mkT_0}\right)^{1/2}\right] \qquad (3)$$

For a cuboid the thickness t of which is much smaller than the other two sides, we have $S/V \simeq 2/t$. Expressing t in terms of the mean de Broglie wave-length, $h\,.\,(2mkT_0)^{-1/2}$, and T_0 as a fraction r of $T_0{}^*$ (the transition temperature for an infinitely large assembly, $S/V \to 0$), we may write:

$$1 = r^{3/2}[1 + 0{\cdot}352/t] \qquad (4)$$

Equation (4) gives the variation of the transition temperature with the film thickness, as shown in Fig. 1. This is in good qualitative agreement with the experimental results of Long and Meyer[3].

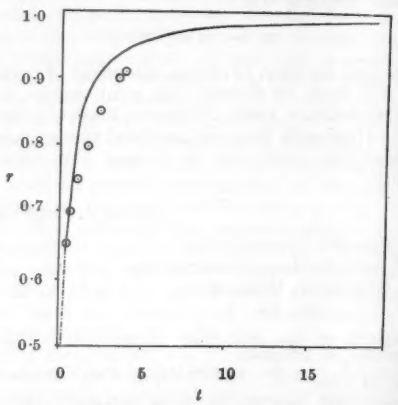

Fig. 1. The onset temperature of superfluidity T_0 (expressed as a fraction r of the transition temperature for bulk) as a function of film thickness t (in units of the mean de Broglie wave-length of the particles). ———, Theoretical curve; ⊙, experimental points of Long and Meyer

It may be noted here that the effect of the decreasing film thickness becomes important when it approaches about ten times the mean de Broglie wave-length. Further, it may be mentioned that the correction term in (4) becomes equal to unity for $t = 0{\cdot}352$, which implies a film of thickness 3·9 A. This limiting thickness is very close to the atomic distance in helium, which means that the three-dimensional approach, modified as above in order to include the effect of the surface term, is valid for films of thickness down to one atomic distance, below which the problem becomes two-dimensional and ceases to remain of practical interest.

A more detailed investigation along these lines, taking into account the interactions in the assembly, is in progress and will be reported elsewhere.

We wish to thank Prof. D. S. Kothari for suggesting this approach and for helpful discussions.

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[1] London, F., *Phys. Rev.*, **54**, 947 (1938).
[2] Osborne, M. F. M., *Phys. Rev.*, **76**, 396 (1949).
[3] Long, E., and Meyer, L., *Phys. Rev.*, **98**, 1616 (1954).
[4] Atkins, K. R., "Progress in Low Temperature Physics", **2**, Chapter 4 (North-Holland Pub. Co., Amsterdam, 1957). Kuper, C. G., *Physica*, **22**, 1291 (1956). Arkhipov, R. G., *Soviet Phys. J.E.T.P.*, **6**, 634 (1958). Atkins, K. R., *Physica*, **23**, 1143 (1957). Ziman, J. M., *Phil. Mag.*, **44**, 548 (1953).
[5] Kothari, D. S., and Auluck, F. C., *Nature*, **159**, 204 (1947).

Effects of Arc Stage of Electrical Discharge on Ignition of Inflammable Gas

THERE is at present no generally accepted criterion of spark ignition. A widely held view is that energy delivered to the gas is the main criterion. Kravchenko[1] has advanced the thesis that the energy in the arc stage of the discharge is the sole criterion, and that other discharge conditions, such as glow, are incapable of giving rise to ignition. During the course of investigation on inductive break-spark ignitions, a number of records of current and voltage across the discharge were taken with high-speed oscilloscopes. A current of 185 m.amp. was interrupted in a 95-mH. inductance series circuit, and the resulting discharge was made to take place in an explosive mixture of 8·3 per cent methane in air. Oscillographic studies of similar discharges in air have been made by Nethercot and Rehfisch[2], with lower time-base sweep-speeds and non-simultaneous recording of current and voltage.

The patterns of arc, glow and multiple spark were found to be similar in the explosive mixture and in air. In general, most records showed arc stages lasting up to some 30 μsec. However, a number of records were obtained where a recognizable arc stage was limited to a few microseconds as in Fig. 1, or was non-existent as in Fig. 2, and these gave normal ignitions in an 8·3 per cent mixture of methane in air. To resolve detail in the multiple breakdowns shown in the records, simultaneous voltage and current recordings were taken at a time-base speed of 0·1 μsec./cm. Fig. 3 shows such a voltage record and Fig. 4 a corresponding current record, taken under conditions identical with those in Figs. 1 and 2. It is seen that nowhere is there a characteristic arc step; the wave carrying a superimposed high-frequency oscillation is likely to be due to the local oscillatory circuit at the contacts. A detailed examination of a number of records has shown that arcs are established at the two levels of 96 and 144 V. and glows at 384 V. It is therefore clear that ignition is not dependent on the arc stage of the discharge.

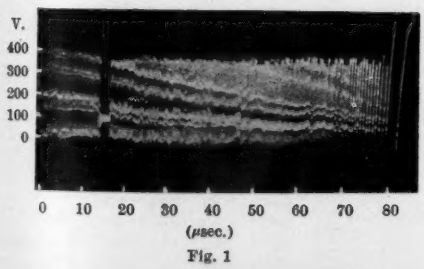

Fig. 1

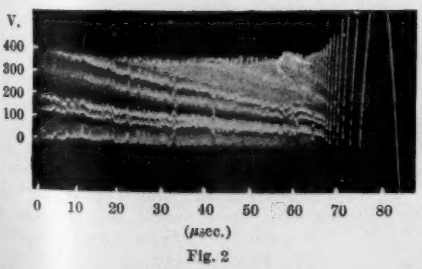

Fig. 2

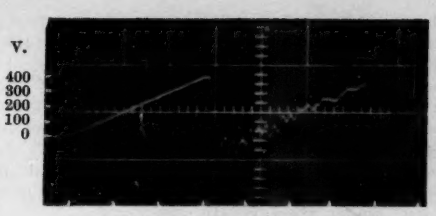

Fig. 3

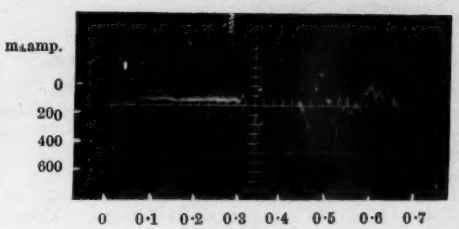

Fig. 4

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[1] Kravchenko, V. S., *Trudy Institute Gornovo Dela*, 203 (1954).
[2] Nethercot, W., and Rehfisch, T. J., E.R.A. Report *G/T* 217 (1948).

WE agree entirely with Mr. Berz that an arc discharge is not essential for the ignition of inflammable gas, but we cannot agree with his statement that the multiple breakdowns shown in his records have none of the characteristics of an arc discharge. We suggest that they are transient arcs of very short duration in which the current is relatively constant as is the voltage, although its value is appreciably greater than that in a sustained discharge.

Multiple discharges, which often occur when inductive circuits are broken, are due to the capacitance associated with the circuit inductance and the opening contacts. At current break this capacitance is charged up at a rate which is dependent primarily on the values of the capacitance and the inductance. For short times the rate of rise of voltage is linear and the charging current is constant, as shown in the oscillograms of Figs. 3 and 4 of Mr. Berz's communication. When the voltage reaches the breakdown voltage of the gap, in this case about 400 V., the capacitive energy $\frac{1}{2}CV^2$ is rapidly discharged through the gap by the establishment of a short transient arc. The capacitance is then recharged through the inductance and the cycle is repeated until the breakdown voltage of the gap rises with increasing gap-width to a value which is greater than the peak value of the open-circuit oscillation.

From the results provided by Mr. Berz's oscillograms it is possible to deduce that the capacitance

in his circuit is about 100 pF., and also that the voltage during the short discharge is about 130 V., which is in reasonable agreement with one of the values he has found for the establishment of an arc. The energy dissipated in each of these short arcs is about 8 microjoules, so that several hundred of them, as shown in the oscillograms of Figs. 1 and 2, are needed to give the total energy of a millijoule or so which is required for the ignition of a methane/air mixture under these conditions.

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A Source of Natural Tin Whiskers

Some years ago, when metal whiskers were discovered growing on plated surfaces in electrical transmission apparatus[1], many investigators began searching for places where natural whiskers might be found essentially undisturbed for many years. A brief reflexion will indicate that such places are not common. Even in museums, articles are cleaned periodically so that natural whiskers which might be on their surfaces are removed.

As a collector of military small arms and accessories, I chanced to discover an excellent source of tin whiskers in almost every German bayonet scabbard from the period before the First World War to the Second World War. The steel retainer springs which hold the bayonet in the steel scabbard were coated with tin to resist corrosion. One has only to remove these springs to observe a lush growth of natural tin whiskers on their surfaces. Fig. 1 shows such a growth on springs from a German bayonet scabbard of the First World War. Growth of whiskers is not entirely general over the free surface of the springs, but appears to be confined mainly to certain areas of relatively high activity. These areas may comprise as much as 80 per cent of the free surface. Patchy growth probably results from an uneven thickness of the tin coating. Such a variation of growth of whiskers with coating thickness has been established by experiment[1]. Retainer springs of the Second World War exhibit similar patterns of incidence of whiskers on their surfaces.

Under high magnification, the whiskers appear to have round or elliptical cross-sections and their surfaces are quite clean and reflective. They exhibit a variety of habits, including straight spires, coiled filaments, kinked spires, and branched whiskers, with the majority being straight. Whiskers from the First World War period commonly reach 5 mm. in length, a few being as long as 12 mm. It is clear from the geometry of the bayonet scabbard that the 12-mm. whiskers, which are about 1μ in diameter, must have grown along the inside wall of the scabbard. However, they are not generally kinked. As expected, much shorter whiskers, having a maximum length of about 2 mm., were noted on the Second World War springs. The variation in diameters between individual whiskers from both First and Second World War springs was 1–10μ.

One of the difficulties with tin whiskers has been the scarcity of specimens of sufficient length for experimental investigation. However, whiskers from the First World War bayonet scabbard springs are quite adequate for most types of testing, and they are plentiful. Undoubtedly, many other sources of long tin whiskers exist, such as the inside surfaces of old tin-coated canteens and cartridge boxes.

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[1] Compton, K. G., Mendizza, A., and Arnold, S. M., *Corrosion*, **7**, 327 (1951).

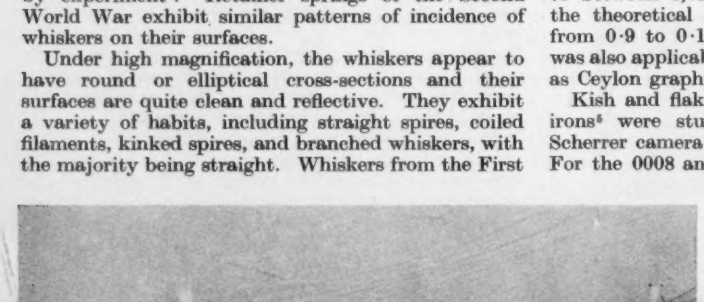

Fig. 1. Tin whiskers on First World War bayonet retainer spring

Structure of Kish and Other Graphites

Franklin[1] assumed that there were only two types of layer in graphitic carbons: parallel and oriented and parallel but disoriented layers. The disoriented layers occur randomly with a probability p, between the oriented layers. From this assumption she obtained a simple formula for the intensity curve in reciprocal space:

$$I = (1 - U^2)/(1 + U^2 - 2U \cos \pi l)$$

where l is the crystallographic index and $U = 1 - p$. This is a special case of the more general intensity formula for X-rays scattered from disordered layer lattices[2,3]. All Franklin's intensity curves of the $11\bar{2}2$ line, obtained with graphitized carbons heated to between 1,720° and 3,000° C., are very close to the theoretical curves, estimated p values ranging from 0·9 to 0·1. Bacon[4] showed that the formula was also applicable to well-crystallized graphites, such as Ceylon graphite, and to three artificial samples.

Kish and flake graphite extracted from grey cast irons[5] were studied similarly. A 24-cm. Debye–Scherrer camera with a thermostat device was used. For the 0008 and $11\bar{2}2$ lines nickel $K\alpha_1$ (θ, 81°) and chromium $K\alpha_1$ (θ, 82°) radiations were used respectively. For the 0008 line pressed specimens 0·7 mm. thick and 6 mm. in diameter were used in order to concentrate the scattering on the 000l lines. For the $11\bar{2}2$ line ordinary rod specimens, diameter 0·7 mm., were used.

The separation of the α_1 line from the $\alpha_1\alpha_2$ doublet and the corrections for the geometrical broadening were carried out by Bracewell's method[6]. In evaluating numerically the integral equation, the geometrical broadening was assumed to be given by the profile of the $11\bar{2}0$ line.

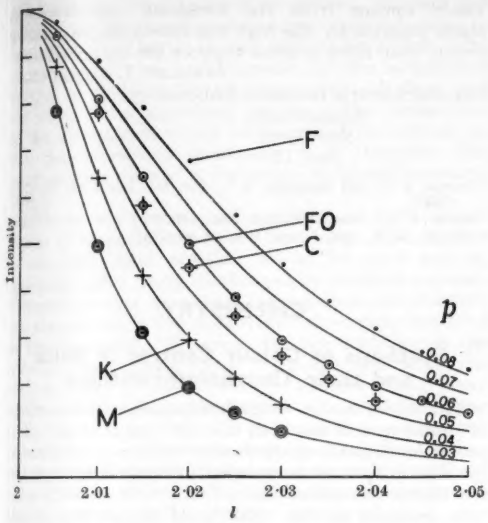

Fig. 1. The intensity distribution in reciprocal space derived from the powder line $11\bar{2}2$ of various graphites

The theoretical intensity curves for the $11\bar{2}2$ line in reciprocal space are shown in Fig. 1. The observed points *F*, *FO*, *C*, *K* and *M* were determined from microphotometer records obtained with the following samples: (*F*) Flake graphite extracted from grey cast iron, used in a previous study[5]. (*FO*) The same sample of flake graphite wet-oxidized for 12 hr. as previously described[5]. After the treatment p decreased from 0·082 to 0·060. (*C*) Ceylon graphite ground in an agate mortar after mixing the sample with small amounts of rock salt and treating the mixture with hydrochloric and hydrofluoric acids. The grain-size was 0·01–0·1 mm.; p was estimated to be 0·055, whereas Bacon's result was 0·050. A slight increase in the proportion of disordered layers was presumably caused by the grinding. (*K*) Kish graphite obtained from the Kamaishi mine, Japan. The sample was neither mechanically nor chemically treated. When it was examined under a microscope well-crystallized pure flakes with flat surfaces were observed. The grain size was 0·1–0·7 mm. Recently, Walker[7] found smaller interplanar distances than normal in untreated Kish containing 48 per cent ash. He attributed this to internal pressures produced when the Kish was formed from molten iron. In my sample no contraction of spacings greater than 0·0001 A., as compared with the Ceylon graphite, was observed. (*M*) Original flakes of Madagascar graphite. The grain size was 0·4–0·8 mm.

As will be readily seen from Fig. 1, the agreement between the observed points and the theoretical curves is striking.

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[1] Franklin, R. E., *Acta Cryst.*, **4**, 253 (1951).
[2] Méring, J., *Acta Cryst.*, **2**, 371 (1949).
[3] Hendricks, S., and Teller, E., *J. Chem. Phys.*, **10**, 147 (1942).
[4] Bacon, G. E., *Acta Cryst.*, **4**, 558 (1951).
[5] Matuyama, E., *Nature*, **170**, 1123 (1952).
[6] Bracewell, R. N., *Aust. J. Phys.*, **8**, 61 (1955).
[7] Walker, Jun., P. L., and Imperial, G., *Nature* 1185, **180**, (1957).

Surface Charges produced on Insulators by Short- and Long-time Ionization

WITH the use of a rotating-probe electrometer[1], high-resolution measurements of induced surface charges have revealed some significant charge differences between short- and long-time periods of ionization. This difference may lead to a better understanding of the mechanism of dielectric failure in the presence of gaseous ionization.

The induced voltage charge pattern on the surface of polyethylene, as measured with the rotating probe electrometer immediately after a d.c. discharge at the inception voltage of a 1-mm. uniform field gap, is shown in the oscillograph trace drawing No. I (Fig. 1). The charge pattern measured a month later is essentially the same as shown in trace No. II (Fig. 1). These patterns show that the polarity of the charge is the polarity of the electrode facing the dielectric surface, that the magnitude of charge is uniform, and that it remains virtually unchanged at normal room conditions for a long period of time.

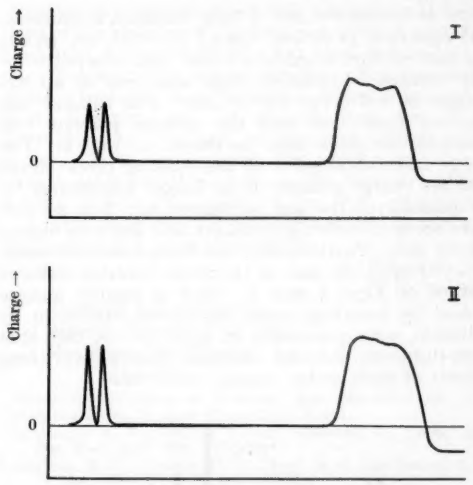

Fig. 1. Positive charge patterns on polyethylene after d.c. discharge (I) and one month later (II)

As shown by Mason[2], if the polarity of the field is reversed, the influence of such a charge could reduce the inception voltage of the gap by as much as 50 per cent. In this case the influence of the charge could be effective a month after its inception. In all these charge measurements marker pips on the left side of the cathode-ray oscilloscope trace are obtained from two wires (0·25 diam.) mounted vertically in plastic 3·5 mm. apart and maintained at a d.c. potential of + 500 volts above ground. The rotating probe picks up an induced voltage from these wires as it passes over the wires and the charged surface. In this manner the magnitude and charge diameter can be determined by measuring the width of the charge pattern at the points of inflexion.

Short-duration 60-cycle ionization tests were made between two parallel polyester resin surfaces separated by 1 mm. A potential of 5·6 kVp. was applied for $1\frac{1}{2}$ cycles.

The charge on both surfaces was then measured at the discharge site. The cathode-ray oscilloscope trace drawings are shown in Fig. 2. The positive charge

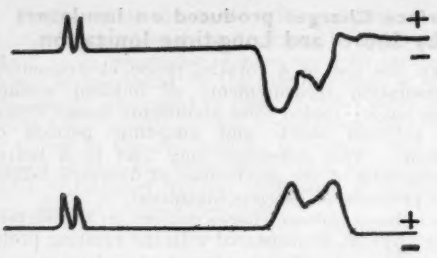

Fig. 2. Charge pattern on opposed surfaces of polyester resin after breakdown at 60 c./s.

on one surface is accompanied by a negative charge on the opposite surface. The charge patterns are not as uniform as obtained from the single discharge shown in Fig. 1. This is probably caused by some neutralization of charge during the polarity reversals; however, the polarity is still essentially determined by the polarity of the opposite electrode at the last half-cycle.

For an ionization test of long duration a stainless-steel electrode (2·54 cm. diam.) of 0·318 cm. radius was used to form a uniform 1-mm. gap to a polyester resin surface. Ionization tests were run at an a.c. voltage of 5·6 kVp. for 27 hr. The sample was removed from test and the charge pattern was obtained two days later as shown in Fig. 3. The charge trace obtained with the rotating probe shows that the charge polarity is no longer determined by the polarity of the last voltage-cycle; but we find small areas of both high positive and negative charge side by side. Furthermore, the charges are not easily removed as in the case of the short-duration induced charges of Figs. 1 and 2. This is readily accomplished by breathing moist air on the surface or by radiation with polonium, in spite of the fact that short-duration induced charges remain over long periods of time under normal conditions.

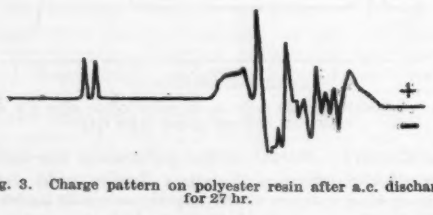

Fig. 3. Charge pattern on polyester resin after a.c. discharge for 27 hr.

It is known that the longer period of ionization results in the breaking of molecular bonds of the polyester resin; but it was not expected that this would result in large differences in charge polarity. On the contrary, it was anticipated that this would result in smoothing out the charges due to the increased surface conduction which is known to occur.

It is believed that longer periods of ionization result in higher energy discharges at selective sites which induce electrons to penetrate deeper into the dielectric, and that this accounts for the high positive and negative charges which occur close to each other and most probably indicate the site where selective erosion occurs. Thomas[3] concluded that negative discharges cause electrons to penetrate into the surface of the dielectric, where they are strongly bound and not easily reached by positive ions. It would appear from the foregoing measurements, made possible by the high resolution of the rotating probe, that there is some support for his conclusions.

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[1] Devins, J. C., and Reynolds, S. I., *Rev. Sci. Instr.*, **28**, No. 11, B (1957).
[2] Mason, J. H., *Proc. Inst. Elect. Eng.*, **100**, Part 2, A, No. 3 (1953).
[3] Thomas, A. M., *Brit. J. App. Phys.*, **2**, 98 (1951).

CHEMISTRY

Synthesis of Colour Centres in Silica and their Thermoluminescence

The colour centre which is responsible for the colour of smoky quartz has been described by O'Brien[1]. The precursor depends upon an aluminium ion substituted for silicon with an associated interstitial lithium ion for charge compensation. The centre consists of a hole trapped in the vicinity of the substitutional aluminium, the lithium having trapped an electron and migrated from the scene. We have now found that combinations of other ions with aluminium in silica powder produce an analogous centre under γ-radiation and have investigated the thermoluminescence of the pure and doped powders after exposure to γ-radiation.

The silica powder was doped by wetting it with solutions of the impurities and heating to 1,500° C. The undoped powder remained colourless after exposure to 10^6 r. γ-radiation from cobalt-60. Powder doped with 0·01 aluminium plus 0·01 lithium became a deep bluish-purple with the same dose. Samples doped with aluminium alone remained colourless after exposure. Cohen[2] showed by his measurements of anisotropy of the absorption that the aluminium must be substitutional. Substitution of aluminium for silicon ion requires charge compensation by a second ion such as that of lithium.

In several experiments lithium was replaced by other ions selected to supply the excess positive charge without necessarily supplying electron traps. Silver, magnesium and phosphorus, when added in combination with aluminium, produced coloration under radiation. Silver may be considered to have an action similar to lithium in being present interstitially and in providing an electron trap. Phosphorus, on the other hand, should be considered substitutional because of its high charge and normal four-fold co-ordination with oxygen. Magnesium must be considered intermediate. These experiments allow us to generalize the impurity centre described by O'Brien.

The undoped silica powder which showed no coloration after exposure had a very intense thermoluminescence with a maximum at about 280° C. when heated at 4 deg. C./min. The exposed silica (aluminium, lithium) showed luminescence maxima in the same region but with lower intensities. The luminescence of silica (0·01 aluminium, 0·01 lithium) was measured for several dose-levels. Although the coloration in these samples increased with dose, the integrated thermoluminescence went through a maximum. The luminescence of the pure silica sample was considered due to a process in which interstitial oxygens plus trapped holes are annihilated with oxy-

gen vacancies plus trapped electrons; Mitchell and Paige[3] had proposed such centres, corresponding to two absorption bands in the ultra-violet region. The quenching of the luminescence of the aluminium centres is evidence for the interaction of these and the ultra-violet absorbing centres. The probability of the interaction would be expected to increase as the concentrations increased and therefore the luminescence showed a maximum at an intermediate dose.

Lithium can play a predominant part in the interaction of these centres while bleaching. The lithium in an interstitial position would be quite mobile, especially after being discharged by electron capture. Phosphorus ions, as well as lithium ions, can stabilize the aluminium in the substitutional position required in the precursor. However, the low mobility of the substitutional phosphorus in comparison with the high mobility of the discharged lithium should have a strong influence on the degree of interaction of the centre upon bleaching. It is planned to extend the investigation of thermoluminescence to silica (aluminium, phosphorus) to test this proposal, and to fused silica with controlled impurities so that the absorption bands can be studied and correlated with the luminescence.

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[1] O'Brien, M. C. M., *Proc. Roy. Soc.*, A, **231**, 404 (1955).
[2] Cohen, A. J., *J. Chem. Phys.*, **25**, 904 (1956).
[3] Mitchell, E. J. W., and Paige, E. G. S., *Phil. Mag.*, Ser. 8, **1**, 1085 (1956).

Beta-Polymorphs of Uranium and Thorium Disilicides

THORIUM disilicide was first described by Brauer and Mitius[1], who isolated single crystals and reported the crystal structure to be tetragonal with the space group $I4/amd$. Later, Zachariasen[2] described an isostructural uranium disilicide observed initially during metallurgical examinations by Kaufmann, Cullity and Bitsianes[3]. Another phase, thought by Kaufmann *et al.* to be U_3Si_2 and also studied by Zachariasen, was found to have a hexagonal crystal structure of the AlB_2-type, space group $C6/mmm$. The crystal structure results led Zachariasen to suggest that this compound was a second form of uranium disilicide and he designated it β-USi_2. The tetragonal uranium and thorium disilicides accordingly became the alpha forms. More recently, Jacobson, Freeman, Tharp and Searcy[4] obtained a thorium silicide isostructural with Zachariasen's β-USi_2, but observed that the silicon content was lower than that of α-$ThSi_2$. They used the description 'β-$ThSi_2$' but suggested that the true composition was $ThSi_{1{\cdot}5\pm0{\cdot}2}$.

We have prepared all the above phases by arc-melting and have examined them by metallographic and X-ray diffraction techniques. A noticeable feature of the preparations is the formation of 'β-USi_2' and 'β-$ThSi_2$' from mixtures containing 62–63 atomic per cent silicon, compared with the 66·7 atomic per cent required for the formation of the alpha disilicides. The compositions of these so-called beta phases accordingly appear to be U_3Si_5 and Th_3Si_5. Our values for the structure cell dimensions are:

U_3Si_5: $a_0 = 3{\cdot}843 \pm 0{\cdot}001$ A.; $c_0 = 4{\cdot}069 \pm 0{\cdot}001$ A.
Th_3Si_5: $a_0 = 3{\cdot}985 \pm 0{\cdot}001$ A.; $c_0 = 4{\cdot}228 \pm 0{\cdot}001$ A.

During an investigation into reactions between the silicides of uranium and thorium and liquid bismuth, two new silicide phases have been isolated. X-ray analysis shows that they are hexagonal with space group $C6/mmm$. These new phases, like the above M_3Si_5 compounds, have the AlB_2-type crystal structure, but the cell dimensions are different and, in particular, the axial ratio $c/a < 1$ compared with $c/a > 1$ for the M_3Si_5 compounds.

Heat treatment of the new thorium–silicon compound in the temperature-range 1,200–1,300° C. transforms it into α-$ThSi_2$, while heat treatment of α-$ThSi_2$ at 850° C. yields the new thorium–silicon phase. It is clear that this compound is in fact the true β-$ThSi_2$ and the analogous uranium compound the true β-USi_2. The structure cell dimensions obtained from X-ray diffraction results are:

β-USi_2: $a_0 = 4{\cdot}028 \pm 0{\cdot}001$ A.; $c_0 = 3{\cdot}852 \pm 0{\cdot}001$ A.
β-$ThSi_2$: $a_0 = 4{\cdot}136 \pm 0{\cdot}001$ A.; $c_0 = 4{\cdot}126 \pm 0{\cdot}001$ A.

Structural characteristics and structure-cell dimensions of the alpha and new beta polymorphs have been compared and a mechanism has been deduced to explain the structure transformation. Furthermore, it appears probable that the atomic arrangements of the M_3Si_5 structure can be derived from that of the β-structure by omission of one-sixth of the silicon atoms. As a consequence, the axial ratio changes from a value less than unity in the beta structure to a value greater than unity in the M_3Si_5 structure.

A more complete and detailed account of the work outlined above is in preparation.

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[1] Brauer, G., and Mitius, A., *Z. anorg. Chem.*, **249**, 325 (1942).
[2] Zachariasen, W. H., *Acta Cryst.*, **2**, 94 (1948).
[3] Kaufmann, A. R., Cullity, B., and Bitsianes, G., *Trans. Amer. Inst. Mech. Eng.*, **209**, 203 (1957).
[4] Jacobson, E. L., Freeman, R. D., Tharp, A. G., and Searcy, A. W., *J. Amer. Chem. Soc.*, **78**, 4850 (1956).

Effect of the Carrier Gas on the Sensitivity of a Thermal-conductivity Detector in Gas Chromatography

IN a recent communication[1], the sensitivity, dt/dx, of a thermal-conductivity cell to small amounts of organic vapours was derived from:

$$t_1 - t_0 = a/K_1 \qquad (1)$$

where t_1 and t_0 are the temperatures of the hot wire and body of the cell respectively, a is constant, and K_1 is the thermal conductivity of the carrier gas. The sensitivity was then shown to be:

$$\frac{dt}{dx} = -\frac{a(K_1 - K_2)}{K_1^2}, \text{ approximately} \qquad (2)$$

where K_2 is the thermal conductivity of the organic vapour and x is its concentration in the carrier gas. From equation 2, carrier gases of low thermal conductivity would be expected to produce the highest sensitivities. However, in practice a is usually varied, and sensitivities should be compared at equal values of t_1. Carrier gases of high thermal conductivity would then give the highest sensitivities.

An expression for a can be derived from a heat-balance equation that considers only the heat loss, from the wire, due to the thermal conductivity of the gas:

$$\frac{I^2R}{J} = CK_1 (t_1 - t_0) \quad (3)$$

where I is the current to the hot wire, R is the resistance of the wire at t_1, J is Joule's constant, and C is a constant for a given cell that depends only on the cell geometry. Rearranging gives:

$$t_1 - t_0 = \left(\frac{I^2R}{JC}\right)\frac{1}{K_1} \quad (4)$$

From equations 1 and 4:

$$a = \frac{I^2R}{JC} \quad (5)$$

Therefore, any change in current (I) or voltage (IR) changes a.

In practice, when the carrier gas is changed, current or voltage is adjusted to permit operating at a high wire temperature, where sensitivity is high. To maintain this wire temperature, a must vary with the thermal conductivity of the carrier gas, as shown by equation 1. Then, a/K_1 is constant, and, by rearranging equation 2:

$$\frac{dt}{dx} = \frac{a}{K_1}\left(1 - \frac{K_2}{K_1}\right) \quad (6)$$

In this case, sensitivity will depend on the factor, $1 - \frac{K_2}{K_1}$, which is largest for the highest value of K_1. For this reason, gases of high thermal conductivity' such as hydrogen or helium, are preferred for maximum sensitivity in the detection of organic vapours.

The increase in cell sensitivity with carrier-gas thermal conductivity has been confirmed by measuring the output voltages developed with prepared mixtures of hydrocarbons or methanol in helium or nitrogen. Table 1 shows the voltages obtained at two levels of cell and wire temperature.

Table 1. Effect of Carrier Gas on Output

°C. t_1	°C. t_0	Vapour	Output, millivolts for 1 mole per cent vapour in: Helium	Nitrogen
100	25	*n*-hexane	21·2	2·20
100	25	methanol	11·0	0·45
200	150	benzene	9·9	0·29
200	150	*cyclo*hexane	10·8	0·20
200	150	*n*-hexane	11·5	0·23

Studies under way in our laboratories will illustrate further disadvantages of using carrier gases of low thermal conductivity.

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Ray, N. H., *Nature*, **182**, 1663 (1958).

It is quite true that the sensitivity of the detector would be higher with a carrier gas of high thermal conductivity, provided that the hot wire can be maintained at the same temperature. In practice, however, it is not always possible to achieve this because the bridge supply voltage is generally fixed by the makers of the instrument at a level which permits safe operation with a gas of low conductivity, and to increase the bridge voltage may necessitate modification to the electrical circuit of the instrument.

There is a further advantage with a carrier gas of low thermal conductivity; the thermal conductivities of organic gases increase more rapidly with temperature than those of monatomic gases such as argon and helium, so that if the operating temperature is raised the thermal conductivity difference, and hence the sensitivity, increases if a carrier of low conductivity is used; whereas with helium the reverse is the case, as shown in Table 1 of Dr. Dinerstein's communication.

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Separation of Strontium-90 from Calcium

One of the main difficulties in determining the strontium-90 content of biological materials such as milk, bone and coral is the separation of strontium from the large amounts of calcium which accompany it. In an endeavour to avoid the rather tedious and time-consuming method based on the insolubility of strontium salts in strong nitric acid[1], various ion-exchange methods have been developed[2–5] in which the alkaline earth ions have first been absorbed on to a cation exchange resin and then successively eluted by agents such as lactate and citrate at a controlled *p*H. Although the amount of strontium in such samples is very small, these methods require the use of a relatively large column of sufficient exchange capacity to absorb at least part of the accompanying calcium as well as the strontium.

In view of the differing stability constants of the calcium and strontium ethylenediamine tetraacetic acid complexes ($\log K_{1Sr} = 8{\cdot}63$, $\log K_{1Ca} = 11{\cdot}0$)[6], a study was made of the absorption of these elements by a cation exchange resin, 'Zeo-Karb 225', in the presence of ethylenediamine tetraacetic acid over the *p*H-range 3–7. In each experiment 25 mgm. of strontium or calcium ions and 1 gm. of disodium ethylenediamine tetraacetic acid were used with a 10-ml. resin column (0·9 cm. internal diam.) in the sodium

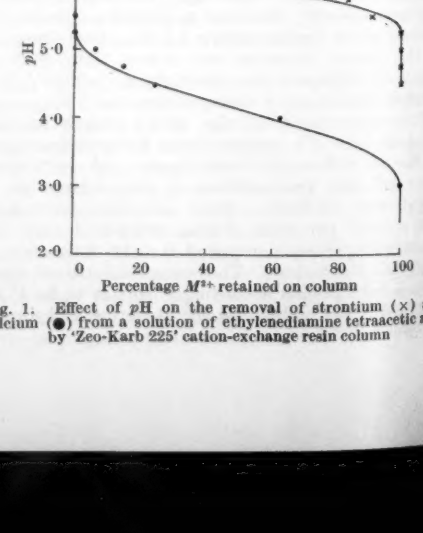

Fig. 1. Effect of *p*H on the removal of strontium (×) and calcium (●) from a solution of ethylenediamine tetraacetic acid by 'Zeo-Karb 225' cation-exchange resin column

form. It is seen from Fig. 1 that at *p*H 5·25, strontium, present in the cationic form, is quantitatively retained on the resin, while calcium is complexed by the ethylenediamine tetraacetic acid and passes through.

These results were confirmed by using the method to separate strontium from prepared strontium–calcium mixtures to which had been added calcium-45 as tracer. The recovery of strontium was checked by eluting the resin with 3 *N* hydrochloric acid and precipitating the strontium as carbonate and weighing. The activity of the carbonate precipitate gave a measure of the degree of contamination of the strontium with calcium. This was shown to be less than 1 per cent.

This ion-exchange recovery of strontium from strontium–calcium mixtures is achieved with the use of very small columns, and should be capable of application to the simple determination of strontium-90 on a routine basis, considerably reducing the time required for each determination.

I wish to acknowledge the assistance of Miss M. Barnett with the experimental work.

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New South Wales. Jan. 21.

[1] Bryant, F. J., Chamberlain, A. C., Morgan, A., and Spicer, G. S., A.E.R.E. *HP/R2056* (1957).
[2] Merritt, W. F., *Can. J. Chem.*, **36**, 425 (1958).
[3] Lerner, M., and Rieman, W., *Anal. Chem.*, **26**, 610 (1954).
[4] Milton, G., and Grummitt, W. E., *Can. J. Chem.*, **35**, 541 (1957).
[5] Farabee, L. B., U.S.A.E.C. Report *ORNL*-1932 (1955).
[6] Bjerrum, J., Schwarzenbach, G., and Sillen, L. G., "Stability Constants of Metal-ion Complexes" (The Chemical Society, London, 1957).

Detection of Keto-Acids

Most of the reported chromatographic work on the identification of keto-acids has involved the paper chromatography of a derivative, usually the 2,4-dinitrophenylhydrazone. A simple technique has been developed in this Laboratory whereby acidic materials which may contain keto-acids are chromatographed directly on Whatman No. 1 paper using a solvent containing ethyl acetate/acetic acid/water (60 : 25 : 15 v/v). After irrigation and drying, the papers are sprayed with a saturated alcoholic solution of 2,4-dinitrophenylhydrazine, dried with hot air for 5 min., and then sprayed with an approximately 5 per cent solution of potassium hydroxide in 90 per cent ethanol. The 2,4-dinitrophenylhydrazones which have been formed *in situ* react to give a variety of colours against an almost colourless background. In general, the derivatives of α-dicarbonyl compounds give colours ranging from light blue to dark purple. Derivatives of other carbonyl compounds produce yellow, red or brown spots. The colour given by any one of these derivatives is often distinctive for that compound, and may sometimes serve to differentiate between keto-acids with similar R_F values.

This method has proved useful recently in work on the ozonization of aqueous solutions of simple aliphatic acids, when mesoxalic acid may be produced. The oxidation products are chromatographed using a method developed here in which a *p*H indicator is incorporated in the solvent[1]. Mesoxalic acid or other keto-acids may have R_F values similar to those of other non-ketonic acids, and accordingly a second chromatogram without *p*H indicator is run and treated in the way described.

As little as 5 μgm. mesoxalic acid can readily be detected by this method.

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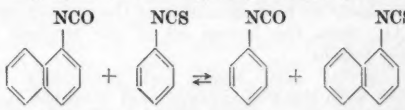
[1] Lawson, G. J., and Hartley, R. D., *Biochem. J.*, **69**, 3 *P* (1958).

Equilibration of *iso*Cyanates and *iso*Thiocyanates

*iso*Thiocyanates have been prepared by several methods[1–4]; I have recently found that they can also be prepared conveniently by the equilibration of *iso*cyanate and *iso*thiocyanate groups. This equilibration occurs slowly at elevated temperatures and appears to be generally applicable to the preparation of *iso*thiocyanates and mixed *iso*cyanates–*iso*thiocyanates.

The reaction is illustrated by the following equation for the preparation of naphthyl *iso*thiocyanate:



This equilibration reaction may proceed through dimer formation. The yields obtained are fair, and considerable residue is formed. Decomposition leading to tar formation may be caused by the prolonged time at considerably elevated temperature required to establish equilibrium. Further study of the reaction and its variables, particularly acceleration of equilibrium formation by catalytic action, might greatly improve the yields.

25 gm. α-naphthyl *iso*cyanate (Matheson, Coleman and Bell) and 21 gm. phenyl *iso*thiocyanate (Matheson, Coleman and Bell) were mixed and heated, with stirring, under reflux at a pot temperature of 215–225° C. for 14 hr. During this period the reaction mixture turned yellow and gradually dark brown. Distillation of the reaction mixture yielded four fractions: 12·3 gm. distillate boiling at 164–168° C. at atmospheric pressure; 4·5 gm. distillate boiling at 44–46° C. at 2–3 mm. mercury; 3·4 gm. distillate boiling at 85–90° C. at 1–2 mm. mercury; 13·6 gm. material boiling at 109–111° C. at 1 mm. mercury. This last fraction solidified on cooling to room temperature. A dark brown tarry residue (8·2 gm.) was left in the reaction flask. The solid material (m.p. 46–54° C.) was dissolved in toluene, the small amount of insoluble material filtered off and the toluene stripped off. The resulting white solid, α-naphthyl *iso*thiocyanate, weighed 12·8 gm. and melted at 56·7–57·5° C.

p-Bromophenyl *iso*thiocyanate (m.p. 61·6–62·0° C.) was prepared by an identical procedure in 35 per cent yield.

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[1] Schroeder, D. C., *Chem. Rev.*, **55**, 194 (1955).
[2] v. d. Kerk, G. T. M., Pluygers, C. W., and deVries, G., *Rec. trav. chim.*, **74**, 1262 (1955).
[3] Schmidt, E., Kammerl, E., Ross, D., and Zaller, F., *Chem. Ann.*, **594**, 233 (1955).
[4] Baxter, J. N., Cymerman-Craig, J., Moyle, M., and White, R. A., *J. Chem. Soc.*, 659 (1956).

Structure of Malvalic Acid and Some Related C_{18} and C_{19} *Cyclo*propane Fatty Acids

In recent years an interesting group of fatty acids containing a *cyclo*propane or a *cyclo*propene ring has been isolated from natural products or synthesized. This work followed the discovery by Hofmann *et al.*[1,2] of a biologically active $C_{19}H_{36}O_2$ *cyclo*propane fatty acid, lactobacillic acid, in the lipides of *Lactobacillus arabinosus* and *L. casei*. Four more C_{19} acids of this type were synthesized[3,4]—the DL, *cis* and *trans*, 9-10 and 11-12, methylene octadecanoic acids. The crystal structures of two of these racemates have been studied[5,6], namely, the DL *trans* 9-10 and DL *cis* 11-12, and shown to have the characteristic straight- and bent-chain configurations illustrated in the electron density Fourier projections in Figs. 1 and 2. From the similarity in the diffraction data, the other two racemates are believed to be structurally isomorphous[7] in the *trans* and *cis* series, respectively. Of these, the DL *cis* 9-10 acid was shown[7] to be identical with the dihydrosterculic acid obtained[4] by hydrogenation of the sterculic acid[8], $C_{19}H_{34}O_2$, from the kernel oil of the tropical tree *Sterculia foetida*.

Lactobacillic acid itself had previously been identified with the phytomonic acid from the lipides of the plant pathogen *Agrobacterium* (*Phytomonas*) *tumefaciens*) which was studied earlier[9,10] but not recognized as a *cyclo*propane acid. From chemical and crystallographic evidence[11] it is now considered to be D or L *cis* 11-12 methylene octadecanoic acid, but this has yet to be completely confirmed by chemical synthesis or single-crystal structure analysis.

More recently, two C_{19} *cyclo*propane fatty acids have been reported, dihydrobombacic acid from the bombacic acid of kapok seed oil[12], and dihydromalvalic acid by hydrogenation of the malvalic acid from the leaves and seeds of *Malva verticillata* and *M. parviflora* and from cotton seed[13,14].

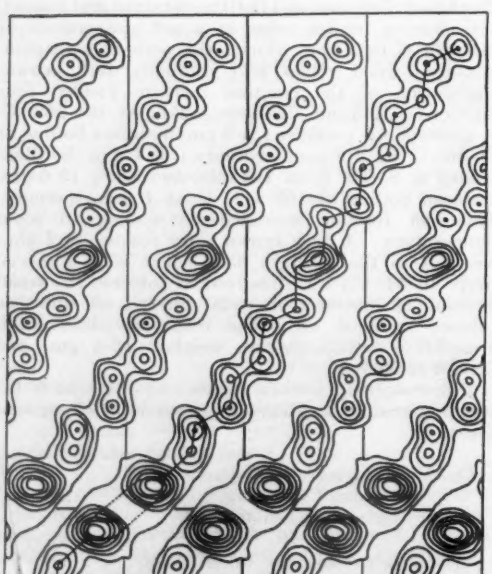

Fig. 1. DL *trans* 9-10 methylene octadecanoic acid

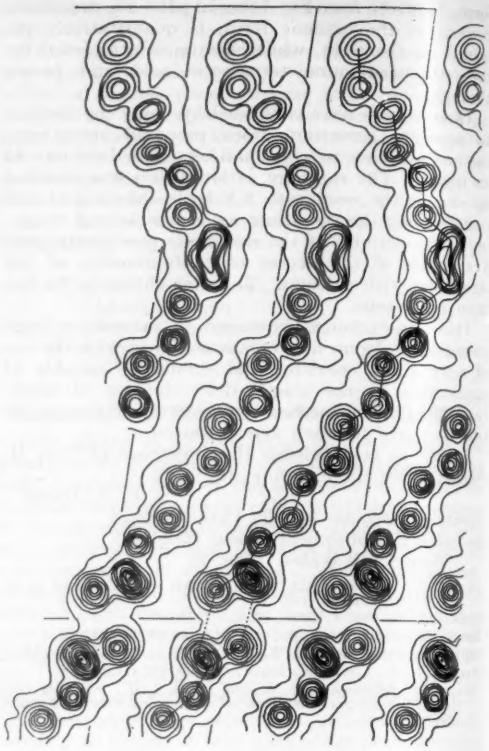

Fig. 2. DL *cis* 11-12 methylene octadecanoic acid

We have carried out a crystal structure analysis of dihydromalvalic acid and have shown it to be DL *cis* 8-9 methylene heptadecanoic acid, that is, DL-*cis*-7-(2-octa *cyclo*propyl) heptanoic acid. The molecule has a boomerang shape, as befitting its country of origin, which is well illustrated in the Fourier projection down the axis shown in Fig. 3. This stereochemistry with the bend at the *cis* substituted ring is analogous to that found in the crystal structure of the synthetic DL *cis* 11-12 methylene octadecanoic acid[6] (Fig. 2), and quite different from the straight chain structure of the DL *trans* 9-10 methylene octadecanoic acid[5] (Fig. 1). A chemical synthesis of this molecule, using the methods devised for the C_{19} acids, is now in progress (Hofmann, K., unpublished work).

If Nunn's *cyclo*propene structure for sterculic acid[8] is accepted, as against the 'conjugated structure' or the 'methylene allene' structure, as generally it appears to be[15,16], malvalic acid can now be assigned the structure (I), on the basis of the chemical and spectroscopic evidence[13,14] and our structure analysis of the dihydro derivative.

$$CH_3—(CH_2)_7—C=C—(CH_2)_6COOH \qquad (I)$$

$$\diagdown\ \diagup$$

$$C$$

$$H_2$$

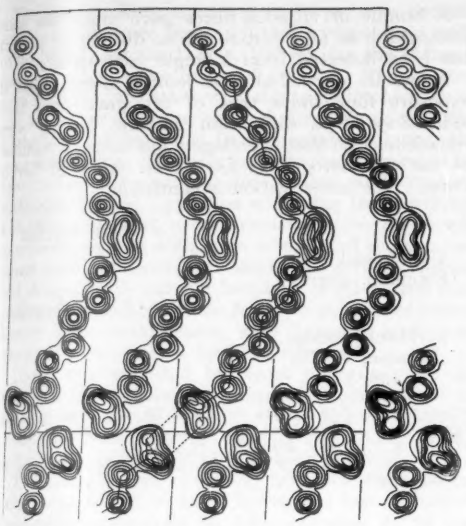

Fig. 3. Dihydromalvalic acid (DL *cis* 8-9 methylene heptadecanoic acid)

This confirmation of the natural occurrence of a C_{18} *cyclo*pentene fatty acid is of interest from the point of view of biosynthesis, since it appears to eliminate a mechanism analogous to the addition of a C_1 fragment to a naturally occurring unsaturated acid as has been proposed in the case of lactobacillic acid[17].

This research is supported by a grant (*E*-1423) from the U.S. Public Health Service, National Institutes of Health. We are grateful to Dr. Vickery, of the Commonwealth Scientific and Industrial Research Organization, Australia, for providing us with the sample of dihydromalvalic acid, and to Prof. K. Hofmann, of the Biochemistry Department of the University of Pittsburgh Medical School, for his close co-operation in our study of these acids.

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Jan. 21.

[1] Hofmann, K., and Lucas, R. A., *J. Amer. Chem. Soc.*, **72**, 4328 (1950).
[2] Hofmann, K., and Sax, S. M., *J. Biol. Chem.*, **195**, 473 (1952).
[3] Hofmann, K., Tucker, O., Miller, W. R., Young, A. C., and Tausig, F., *J. Amer. Chem. Soc.*, **76**, 1799 (1954).
[4] Hofmann, K., Orochena, S. F., and Yoho, C. W., *J. Amer. Chem. Soc.*, **79**, 3608 (1957).
[5] Brotherton, T., Craven, B., and Jeffrey, G. A., *Acta Cryst.*, **11**, 546 (1958).
[6] Craven, B., and Jeffrey, G. A., *Acta Cryst.* (in the press).
[7] Brotherton, T., and Jeffrey, G. A., *J. Amer. Chem. Soc.*, **79**, 5132 (1957).
[8] Nunn, J. R., *J. Chem. Soc.*, 313 (1952).
[9] Chargaff, E., and Levine, M., *J. Biol. Chem.*, **124**, 195 (1938).
[10] Velick, S. F., *J. Biol. Chem.*, **152**, 533 (1944).
[11] Hofmann, K., Marco, G. J., and Jeffrey, G. A., *J. Amer. Chem. Soc.*, **80**, 5717 (1958).
[12] Dykstra, G., and Duin, H. J., *Nature*, **176**, 71 (1955).
[13] Shenstone, F. S., and Vickery, J. R., *Nature*, **177**, 94 (1956).
[14] Macfarlane, J. J., Shenstone, F. S., and Vickery, J. R., *Nature*, **179**, 830 (1957).
[15] Crombie, L., "Ann. Rep. on Progress of Chem. for 1957", **54**, 206 (1957).
[16] Brooke, D. G., and Smith, J. C., *Chem. and Indust.*, 1508 (1957).
[17] Hofmann, K., Henis, D. B., and Panos, C., *J. Biol. Chem.*, **288**, 349 (1957).

BIOCHEMISTRY and PHYSIOLOGY

Polysaccharide Fibres in Mammalian Connective Tissue

THE presence of fibres which differ chemically and physically from the contiguous collagen and elastin in mammalian and other connective tissue has been reported previously[1]. Four types of fibres were defined upon the basis of morphological variations as observed with the optical microscope and described as redimiculous, vitreous, jointed and barbed[2]. None of these exhibits hydrothermal contraction associated with collagen, and they all resist acid hydrolysis and digestion by collagenase and elastase. Mechanical deformation of individual fibres produces sharp fractures with the vitreous, jointed and barbed types, while the redimiculous variety exhibits predominantly plastic distortion. The absence of the elastic recovery associated with normal protein fibres of connective tissue, added to the other differences, indicates a molecular structure completely different from that of the fibrous proteins.

Morphologically, the redimiculous fibres are similar to cotton fibres in that they consist of helically disposed fibrils with the helix angles changing along the fibre axis as the ends taper. They have approximately the same birefringence as raw cotton and exhibit the characteristic ability to produce this at all angles to the polarized beam. The vitreous fibres show similar birefringence, but no helical fibril assemblies have been observed and there are marked differences in fibre diameters between them. They also exhibit extinction in the usual uniaxial manner. All four types show a sporadic distribution in tissue and areas of local concentration occur adjacent to zones predominantly protein, that is, collagenous. The numbers of the types present decrease in the order redimiculous–vitreous–jointed–barbed. They have not been definitely associated with any pathological changes as yet and the only correlation reported is a general increase in numbers with the age of the tissue[3].

The specimens studied have all been removed from either fresh or fixed tissue by needles, washed in distilled water, and then observed in both normal and polarized light. Recent work by Cruise and Keech (to be published shortly) has shown that when these individual fibres are ground in a conventional tissue grinder and the suspensions are examined with the electron microscope, no evidence of the 640 A. striations associated with collagen is obtained. Each of the four types produced angular quasi-crystalline units dispersed among plastic fibrous debris, suggesting that these fibres are essentially two-phase structures.

Hall *et al.*[4] have reported that a complicated acid, alkali and enzymatic digestion of bovine dermis results in a fibrous residue of what they term 'mammalian cellulose', which gives an X-ray diffraction diagram similar to that from partially oriented cotton fibres. In view of the known resistance of these polysaccharide fibres to the reagents used, it would appear that this treatment has in effect concentrated these fibres from a random distribution in the fresh dermis to a residual mass. These workers have described two types of fibres appearing in the tissue and the residue, one of which they term anisotropic, and which corresponds morphologically with the redimiculous fibres, and the other which they term

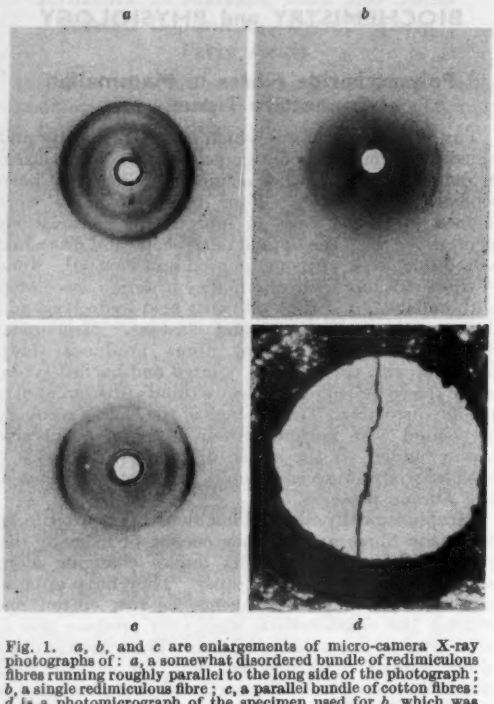

Fig. 1. *a*, *b*, and *c* are enlargements of micro-camera X-ray photographs of: *a*, a somewhat disordered bundle of redimiculous fibres running roughly parallel to the long side of the photograph; *b*, a single redimiculous fibre; *c*, a parallel bundle of cotton fibres: *d* is a photomicrograph of the specimen used for *b*, which was fastened across a hole in copper foil (actual diameter, 0·86 mm.)

a two-phase structure. This appears to be identical with a vitreous type described by Cruise[3] from human Achilles tendon. They suggest that this type is probably composed of a collagen core upon which has been deposited *in vivo* a cellulose coating. In view of the electron microscope disintegration studies of Cruise and Keech this seems doubtful, as no evidence of collagen-like constituents was observed when individual fibres were examined. With this exception there are obvious similarities between the various morphological and optical findings, and attempts were made to obtain X-ray diffraction diagrams from individual fibres to investigate their molecular structure.

Fibres were teased from tissue under the optical microscope and after identification were collected into 'typed bundles' of 5–20 fibres. These and some single fibres were mounted across 1-mm. holes in metal strips and photographed with copper $K\alpha$ radiation from an Ehrenberg–Spear fine focus X-ray tube running at 50 kV., 2 m.amp. and modified to give a focus of 1·0 mm. × 0·1 mm. Diffraction patterns were photographed with a cylindrical camera of 1·0 cm. radius.

Fig. 1 shows some of the photographs: (*a*) of a somewhat disordered bundle of animal redimiculous fibres running roughly parallel to the long side of the photograph; (*b*) of a single human redimiculous fibre; (*c*) is a photograph of a bundle of cotton fibres for comparison; (*d*) is a photomicrograph of the single fibre. The resemblance to native cellulose is very striking, and confirms that the fibres photographed by Hall *et al.*[4] had not been altered by the somewhat drastic treatment used for concentrating them and that these fibres are essentially the same in both human and animal tissue.

A bundle of vitreous fibres gave much the same photograph as (*a*); but so far no diffraction pattern has been detected from a single vitreous fibre.

A bundle of well-aligned jointed fibres, with an exposure four times that of (*a*), gave only faint indications of a diffraction pattern, having some resemblance to that of collagen, but none to cellulose. So far no photographs have been taken of barbed fibres. The investigation is continuing.

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[1] Cruise, A. J., *J. Soc. Leath. Tr. Chem.*, **39**, 252 (1955).
[2] Cruise, A. J., *J. Soc. Leath. Tr. Chem.*, **40**, 321 (1956).
[3] Cruise, A. J., *J. Roy. Micro. Soc.*, **77**, 1 (1958).
[4] Hall, D. A., Lloyd, P. F., Saxl, H., and Happey, F., *Nature*, **181**, 470 (1958).

Incorporation of Radioactive Iron into Hæmatin *a*

The rate of synthesis of hæmoproteins has been studied by measuring their incorporation of iron-59. Most of these studies have concerned hæmoglobin, but some[1,2] also myoglobin, catalase, cytochrome *c* and cytochrome b_5. No report on the incorporation of iron-59 into cytochrome oxidase has yet appeared. Except for cytochrome *c* and cytochrome oxidase, the above pigments all contain protohæm, so that measurement of their individual uptake of iron-59 requires their previous separation, which is often difficult.

In the present work, the fact that cytochrome oxidase (cytochromes $a_3 + a$) has a unique prosthetic group (hæm *a*) which we can readily separate from protohæm, facilitated the study of the synthesis of this enzyme in heart, liver and kidney of rats. Preliminary work had been carried out by D. B. Morell and A. Basser at the Institute of Medical Research of the Royal North Shore Hospital, Sydney (unpublished work), who found some evidence for a greater uptake of iron-59 in hæm *a* of liver than in that of heart. The work of Gallagher, Judah and Rees[3], who studied the effect of copper deficiency in rats, also indicated that hæm *a* was rapidly synthesized in the liver.

Rawlinson and Hale's method[4] for separation of hæmin *a* and protohæmin was improved and incorporated in a method of isolation which gives hæmin *a* usually containing less than 10 per cent of admixed protohæmin in a yield of 80–90 per cent of that present in the first extract from the tissues; protohæmin free from hæmin *a* is obtained in approximately 50 per cent yield.

The freshly excised organs were squeezed thoroughly in heparinized saline so as to remove as much blood as possible, and washed with saline. Homogenates prepared in homogenizers of the Potter–Elvehjem type were washed twice with 0·2 *M* sodium acetate buffer of *p*H 5·2 to remove hæmoglobin and myoglobin. The residue was treated with a solution containing 2 ml. of *n*-butanol per 30 ml. of water for 10 min. at 45° C. and finally washed twice with 80 per cent aqueous acetone (v/v).

The hæmins were extracted by 80 per cent acetone containing 0·7 per cent (w/v) of hydrochloric acid, using 50 ml. for the hearts, 100 ml. for the kidneys, and 300 ml. for the livers of 10 rats. The hæmins were brought into ether with dilute hydrochloric acid and the ether solutions washed three times with the dilute acid, adding some ferrous sulphate during the second washing. The hæmins were then separated by distribution between pyridine – ether and aqueous hydrochloric acid – pyridine according to Rawlinson and Hale's method, except that the ether phase was repeatedly washed with large amounts of the aqueous phase until the absorption band of protohæmochrome had disappeared, leaving hæmin *a* of 90–95 per cent purity. The hæmins of the first two aqueous extracts, almost pure protohæmin, were brought back into ether with 10 per cent hydrochloric acid.

Blood was collected by heart puncture, and an ether solution of its protohæmin prepared from it. Ferritin was isolated in rather low yield from a portion of the liver homogenate as described by Theorell *et al.*[1] and its iron determined by Trinder's method[5].

The hæmins were extracted from their ether solutions with 0·1 *N* sodium hydroxide and measured spectrophotometrically as hæmochromes in 20 per cent pyridine – 0·1 *N* sodium hydroxide – sodium dithionite, applying the formula of Lemberg *et al.*[6]. Hæmin iron was calculated by assuming a molecular weight of 652 for protohæmin and 870 for hæmin *a*.

Radioactivity was counted in an annular well scintillation counter and corrected, for decay, to the day of injection. The total isolation procedure could be carried out in three days.

Ten rats weighing about 150 gm. each were used for each experiment. Each rat received intraperitoneally about 2 μc. labelled ferric ammonium citrate containing 5–10 μgm. of iron and giving a count of 102,000 per min.

Table 1

	Counts/min. per 10 rats with standard deviations* after 7 days	14 days	Specific activities (counts/min./μgm. iron) after : 7 days	14 days
Blood†	337,000±2,100	389,000±1,000		
Protohæmin				
Heart	50±3·5	62± 4	8·7	6·9
Kidney	289±12	131±10	8·4	8·4
Liver	1,180±46	2,050±46	8·2	8·2
Blood	—	—	8·8	8·1
Hæmin *a*‡				
Heart	24± 2·5	26± 3	4·5	3·9
Kidney	104± 6	92± 4	9·6	9·8
Liver	212±10	280±20	12·9	12·5
Liver/ ferritin§	33,600±600	12,700±370	12·9	6·0

* Standard deviations apply only to the counting procedure.
† Assuming the blood volume of the rat to be 10·0 ml.
‡ Specific activities corrected for protohæmin content which was as follows: after 7 days, heart 6, kidney 7, liver 10 per cent; after 14 days, heart 0, kidney 1, liver 27 per cent.
§ Isolation incomplete.

As expected, most of the radioactive iron is found in the ferritin and hæmoglobin. The specific activities, however, of the hæmins isolated from the organs are similar to those of hæmoglobin–protohæmin. There are no significant differences of blood protohæmin and the protohæmin from the organs, with the possible exception of the heart. A substantial and variable part of the protohæmin isolated from the organs is, however, derived from hæmoglobin and myoglobin, which our procedure failed to remove completely, and not from cytochromes of type *b*.

The specific activity of hæmin *a* proves that iron is rapidly incorporated into the cytochromes of type *a*. A comparison of the specific activities of protohæmin and hæmin *a* shows that the incorporation into hæm *a* exceeds that into protohæm in the kidney and especially in the liver, whereas in the heart the hæm *a* activity is distinctly smaller. These findings agree with the observations of Gallagher, Judah and Rees[3] that cytochrome oxidase and hæmin *a* rapidly decrease in copper deficiency and are rapidly restored by copper, and that the decrease is more marked in the liver than in the kidney. Their experiments differ, however, from ours in that a physiologically abnormal deficiency of hæm *a* was present which may have provided an extra stimulus for hæm *a* synthesis.

The differences between the one- and two-week experiments are scarcely significant, except that the total activity in hæmoglobin has risen, and the specific activity in liver ferritin has decreased, as expected. Experiments will be carried out with shorter times of incubation to obtain more information on the rates of incorporation of iron. It will also be of interest to see whether hæm *a* is synthesized *in vitro* by liver homogenates, as Minakami, Yoneyama and Yoshikawa[7] have recently reported for cytochrome *b*.

We are indebted to Prof. C. Rimington for allowing this work to be carried out in his Department, and for his help in the animal experiments, to Miss E. M. Clarkson for the estimation of the iron content of the ferritin preparations, and to the Australian National Health and Medical Research Council for a travel grant.

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[1] Theorell, H., Béznak, M., Bonnichsen, R., Paul, K. G., and Åkesson, Å., *Acta Chem. Scand.*, **5**, 445 (1951).
[2] Loftfield, R., and Bonnichsen, R., *Acta Chem. Scand.*, **10**, 1547 (1956).
[3] Gallagher, C. H., Judah, J. D., and Rees, K. R., *Proc. Roy. Soc.*, B, **145**, 134 (1956).
[4] Rawlinson, W. A., and Hale, J. H., *Biochem. J.*, **45**, 247 (1949).
[5] Trinder, P., *J. Clin. Path.*, **9**, 170 (1956).
[6] Lemberg, R., Bloomfield, B., Caiger, P., and Lockwood, W. H., *Austral. J. Exp. Biol. Med. Sci.*, **33**, 446 (1955).
[7] Minakami, Sh., Yoneyama, Y., and Yoshikawa, H., *Biochim. Biophys. Acta*, **28**, 447 (1958).

Rate of Exchange of Phosphate in Red Blood Cells : Effect of Thyroid Hormones

A method for the *in vivo* determination of the rate of exchange of phosphate in red blood cells by means of the $s^{32}P$ coefficient has already been described. This coefficient measures the outflow of phosphorus-32 from circulating labelled red blood cells[1]. It has been shown that $s^{32}P$ represents the turnover-rate of acid-soluble phosphate in the red blood cell[2].

The exchange-rate of phosphorus-32 has been studied by means of this technique in man and rat under different conditions of thyroid activity.

In euthyroid men, the mean value of $s^{32}P$ for 170 determinations is $4{\cdot}4 \pm 0{\cdot}3 \times 10^{-4}$/min. Hyperthyroidism (32 cases) and hypothyroidism (23 cases) are characterized by $s^{32}P$ coefficients of $5{\cdot}3 \pm 0{\cdot}4$ and $3{\cdot}3 \pm 0{\cdot}4 \times 10^{-4}$/min. respectively.

In the rat, the mean value of $7{\cdot}0 \pm 0{\cdot}5 \times 10^{-4}$/min. in 20 controls reaches $7{\cdot}9 \pm 0{\cdot}4$ (17 animals) after treatment with thyroid extract for 30 days and decreases to $5{\cdot}7 \pm 0{\cdot}5$ (20 animals) after continuous administration of methyl-mercapto-imidazol for the same period of time. In these various conditions there was no significant modification of the soluble phosphate concentration of the red blood cells. It was possible to establish a high correlation between the variations of the $s^{32}P$ coefficient and the basal oxygen consumption measurements.

These findings imply a close relationship between thyroid activity and the turnover-rate of acid-soluble phosphate in the red blood cells. From preliminary *in vitro* experiments, it seems that the thyroid hormone acts directly on phosphate transfer: *in vitro* addition of *l*-triiodothyronine (5 μgm. per cent) to labelled red blood cells, incubated in non-radioactive plasma of myxœdematous patients, is followed by an increase of the outflow-rate of phosphorus-32.

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[1] Ermans, A. M., *C.R. Soc. Biol.*, **147**, 1525 (1952).
[2] Ermans, A. M., "Influence de l'activité thyroïdienne sur la vitesse d'échange du phosphore globulaire. Bases physiologiques et applications cliniques" (Editions Acta Clinica Belgica, 1958).

Enzymatic N-Methylation of Histamine

The *in vivo* studies of Schayer[1] have shown ring N-methylation to be the principal pathway of histamine metabolism in a variety of mammalian species. His work demonstrates the following scheme:

histamine ⟶ 1-methyl-(β-aminoethyl) imidazole (methylhistamine) ⟶ 1-methylimidazole-4-acetic acid

Kobayashi[2] found that incubation of histamine with whole-liver homogenates resulted in the formation of 1-methylimidazole-4-acetic acid. These observations reflect the summation of at least three enzymatic processes, one of which is concerned with the synthesis of a co-factor needed for histamine methylation. This report describes the isolation and properties of an enzyme, imidazole N-methyl transferase, which catalyses the ring-N-methylation of histamine requiring S-adenosylmethionine as the methyl donor.

The enzyme was purified approximately eight-fold in two steps from the soluble supernatant fraction of mouse liver. After homogenization of mouse liver with 4 vol. of isotonic sucrose and centrifugation at 78,000*g*, the supernatant fraction was adjusted to *p*H 5·0 with dilute acetic acid and heated for 5 min. at 50° C. After centrifugation, the precipitate was discarded and the supernatant fluid fractionated with ammonium sulphate. The protein fraction precipitated between 50 and 70 per cent saturation was centrifuged, dissolved in 0·01 *M* phosphate buffer *p*H 7·4 and dialysed against 0·001 *M* phosphate buffer *p*H 7·4 overnight. The partly purified enzyme can be stored frozen for several weeks at − 10° C. without loss of activity.

Enzymatically formed methylhistamine was extracted with chloroform at alkaline *p*H[3]. Under these conditions, 88 per cent of the methylhistamine, but only 7 per cent of the histamine, are extracted into the chloroform.

Table 1 shows the absolute requirement by the purified enzyme for S-adenosylmethionine. Magnesium ions and reduced glutathione are not necessary in this system. Furthermore, dialysis of the enzyme against versene or the addition of versene to the reaction mixture does not alter the enzymatic activity. This indicates that imidazole-N-methyl transferase differs from catechol-O-methyl transferase[4]. Enzymatic activity is not altered by pretreatment of animals with 'Marsilid', a monoamine oxidase inhibitor which blocks the conversion of methylhistamine to 1-methylimidazole-4-acetic acid[3].

Table 1. Requirements for Ring-N-Methylation of Histamine by Purified Mouse Liver Enzyme

Reaction mixture*	Methylhistamine formed (μmoles)
Whole system	0·041
Whole system + 2 mgm. reduced glutathione	0·043
Omit magnesium chloride	0·044
Omit S-adenosylmethionine	0·000
Preheated enzyme	0·000

* Reaction mixture containing 2 ml. 0·1 *M* phosphate buffer *p*H 7·4, 0·5 ml. purified mouse-liver enzyme (0·22 mgm. protein), 0·4 μmoles S-adenosylmethionine, 20 μmoles magnesium chloride, 0·05 μmoles histamine dihydrochloride labelled with carbon-14 (Nuclear Chicago) (12,500 c.p.m.), in a final volume of 3·0 ml. was incubated at 37° C. for 4 hr.

The reaction mixture was saturated with sodium sulphate after the addition of 0·5 ml. of 5 *N* sodium hydroxide and the methylhistamine extracted with 15 ml. chloroform. An aliquot of chloroform was evaporated to dryness, the residue eluted with 0·5 ml. of hyamine (ref. 8) and phosphor and counted in a 'Tri Carb' liquid scintillation counter.

The enzymatic product was proved to be methylhistamine by three techniques. After cochromatography in ethanol/0·1 *N* hydrochloric acid (95 : 5) of the enzymatic product and synthetic methylhistamine[3], a radioautograph demonstrated a single spot which exactly coincided in R_F and shape with the ninhydrin-stained area. The specific activity remained constant after four recrystallizations as the dipicrate[5] with added carrier. Finally, incubation with mouse liver homogenate formed radioactive 1-methylimidazole-4-acetic acid. This was proved as follows: Enzymatically formed methylhistamine was incubated with whole mouse liver homogenate for 4 hr. The mixture was boiled, filtered and passed through a 'Dowex-1'-acetate 100–200 mesh column (10 cm. × 1 cm.). The column was washed and then eluted with 0·5 *N* acetic acid. After concentration of the eluate, it was recrystallized from acetone/water with carrier 1-methylimidazole-4-acetic acid (synthesized from cyanomethylimidazole[6] by Pyman's method[7]). There was no decrease in specific activity after four recrystallizations while carrier imidazole acetic acid could readily be freed of radioactivity by this technique.

Imidazole-N-methyl transferase has been found to be present in most tissues of all species studied so far, and appears to be of paramount importance in histamine metabolism. A more detailed study of this enzyme will be the subject of a future communication.

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[1] Schayer, R. W., *Brit. J. Pharmacol.*, **11**, 472 (1956).
[2] Kobayashi, Y., *Arch. Biochem. Biophys.*, **77**, 275 (1958).
[3] Rothschild, Z., and Schayer, R. W., *Biochim. Biophys. Acta*, **30**, 23 (1958).
[4] Axelrod, J., and Tomchick, R., *J. Biol. Chem.*, **233**, 702 (1958).
[5] Schayer, R. W., and Karjala, S. A., *J. Biol. Chem.*, **221**, 307 (1956).
[6] Bauer, H., and Tabor, H., *Biochem. Preparations*, **5**, 97 (1957).
[7] Pyman, F. L., *J. Chem. Soc.*, **99**, 2172 (1911).
[8] Passmann, J. M., Radin, N. S., and Cooper, J. A. D., *Anal. Chem.*, **28**, 484 (1956).

Inactivation of Isoniazid by Peroxidase

INVESTIGATIONS on enzymes of *Mycobacteria* reported from this laboratory[1] and elsewhere[2,3] have shown the importance of cellular peroxidase for the activity of isoniazid. Results of an extension of these studies bearing on the effect of peroxidase on the tuberculostatic activity of isoniazid form the basis of the present communication.

Using *Mycobacterium tuberculosis H37Rv* as the test organism, growth studies were carried out on Youman's medium (without serum) and the observations were made usually at the end of three weeks incubation at 37° C. Horse-radish peroxidase (obtained through the courtesy of Dr. E. F. Hartree, Molteno Institute of Biology and Parasitology, Cambridge), beef-liver catalase (Boehringer) and mammalian cytochrome c (Boehringer) were sterilized by Seitz filtration, whereas hæmin (Roche), hæmoglobin (Difco) and isoniazid (Roche) were autoclaved; 0·05 c.c. of the test organism, grown for 10 days on Dubos 'Tween' albumin medium, was used as the inoculum per tube.

Table 1. EFFECT OF PEROXIDASE AND RELATED COMPOUNDS ON GROWTH-INHIBITION OF *Mycobacterium tuberculosis H37Rv* BY ISONIAZID

Supplement	Conc. γ/c.c.	Isoniazid (γ/c.c.)							
		0	0·05	0·1	0·5	1	5	10	25
None (control)		+	+	−	−	−	−	−	−
Peroxidase	3	+	+	+	+	+	+	+	+
	1·5	+	+	+	+	+	+	+	−
	0·6	+	+	+	+	+	+	−	−
	0·3	+	+	+	+	+	+	−	−
	0·15	+	+	+	+	+	−	−	−
	0·03	+	+	+	+	+	−	−	−
	0·015	+	+	+	+	−	−	−	−
Peroxidase (inactivated)	3	+	+	−	−	−	−	−	−
Hæmin	10	+	+	+	+	+	+	+	+
	5	+	+	+	+	+	+	−	−
	2·5	+	+	+	+	+	−	−	−
	1	+	+	+	+	−	−	−	−
	0·5	+	+	−	−	−	−	−	−
Catalase	10	+	+	−	−	−	−	−	−
Hæmoglobin	10	+	+	−	−	−	−	−	−
Cytochrome *c*	10	+	+	−	−	−	−	−	−

+, growth; −, no growth.

The mean results of several experiments are summarized in Table 1. Fisher[4] first demonstrated, later confirmed by Knox[5], that hæmin strongly antagonized isoniazid. It was further shown that it breaks up isoniazid to di*iso*-nicotinoyl-hydrazine and *iso*-nicotinic acid[6,7]. In the present study, it is seen that while on a weight basis peroxidase is 100 times as active as free hæmin, on the basis of its hæmin content, which is 2·5 per cent, it is 4,000 times more active. The fact that inactivated (autoclaved) peroxidase showed no effect indicates that the reaction is enzymatic and specific, since the other hæm-proteins were without activity.

These experiments were carried out with extracellular peroxidase. Isoniazid-susceptible tubercle bacilli have, however, the peroxidase at the surface and intracellular. Thus, isoniazid could be fixed to the bacteria and broken down within the cell. If the breakdown products are liberated outside by extracellular peroxidase, they may not enter the bacterial cell.

Much work has been done on the possible modes of the action of isoniazid. Investigations of our own demonstrated that isoniazid does not act by inhibition of either catalase or peroxidase[8], and we proposed a mechanism by which isoniazid is fixed to susceptible cells and metabolized with a peroxidase–oxidase system[9] similar to that of tryptophan proposed by Knox and Mehler[10].

That the activity of isoniazid may be due to its breakdown to peroxide is not supported by the fact that the more peroxide-susceptible, catalase-negative mutants are, on the contrary, resistant to the drug. Further, the action of peroxidase is also not merely due to its removal of peroxide, since otherwise catalase should have been equally effective.

These studies emphasize that the breakdown products of isoniazid, other than peroxide, eventually exert the inhibitory effect by blocking an essential function once they are transported across the cell membrane into the cell.

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[1] Tirunarayanan, M. O., and Vischer, W. A., *Amer. Rev. Tubere.*, **75**, 62 (1957).
[2] Andrejew, A., Gernez-Rieux, Ch., and Tacquet, A., *Ann. Inst. Pasteur*, **91**, 586 (1956).
[3] Hedgecock, L. W., and Faucher, I. O., *Amer. Rev. Tubere.*, **75**, 670 (1957).
[4] Fisher, M. W., *Amer. Rev. Tubere.*, **69**, 469 (1954).
[5] Knox, R., *J. Gen. Microbiol.*, **12**, 191 (1955).
[6] Krüger-Thiemer, E., *Naturwiss.*, **42**, 47 (1955).
[7] Albert, A., and Rees, C. W., *Biochem. J.*, **61**, 128 (1955).
[8] Tirunarayanan, M. O., and Vischer, W. A., *Naturwiss.*, **43**, 474 (1956).
[9] Tirunarayanan, M. O., and Vischer, W. A., *Naturwiss.*, **44**, 11 (1957).
[10] Knox, W. E., and Mehler, A. H., *J. Biol. Chem.*, **187**, 419 (1950).

Quantitative Estimation of Purines by the Visual Scanning of Photographs of Paper Chromatograms

ESTIMATION of microquantities of purines by paper chromatography was first suggested by Hotchkiss[1]. Later, detection by photographing with an ultraviolet source has amplified the method[2]. Tennent *et al.*[3] and others have designed adaptors for the Beckman spectrophotometer to enable direct estimation of the purines from paper chromatograms. This method requires costly instrumentation, and is time-consuming unless an automatic recorder is provided.

Other authors have estimated the size of the spot[4] produced on the photograph.

To obtain a quantitative relationship between area and concentration it is necessary that a spot of accurate dimensions be placed on the starting line. This is frequently difficult. We have been able to produce quantitative results by the scanning of photographs on an automatically recording (visual) densitometer designed by us and reported in detail in a subsequent paper. The densitometer has a high sensitivity, which enables density as well as area definition to be recorded.

Fig. 1, showing typical calibration curves of adenine and adenosine, was obtained by the following method. The standards 0·02, 0·04 and 0·08 μmole of the substance were spotted on to Whatman No. 1 paper. The three concentrations were developed on the same paper with *iso*-propyl ether, 90 per cent (w/v) formic acid, (3 : 2)[5] for 6 hr. by the ascending technique. The papers were then dried and photographed by contact photography on to 'Kodagraph' contact paper (extra thin) using a B.G.E. germicidal lamp to produce the image[6]. The print was slightly over-exposed to ensure an even black background.

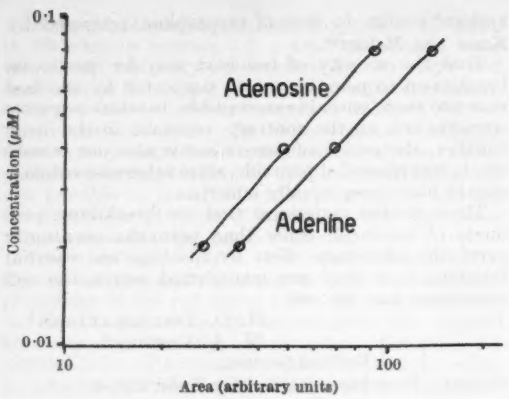

Fig. 1

The print was then developed, fixed and dried in the usual way. The print was cut in 2-in. strips and scanned. The record produced gave a tracing of the absorption of the spot. The area under the curve was estimated with an 'Allbrite' planimeter, and this area was plotted on a double logarithmic graph against the concentration of the purine. The resulting plot gave a linear calibration. It was found that the base-line obtained on such a curve was more stable than that obtained by scanning a blank filter paper. The method is also applicable to other substances, such as steroids[7], which have absorption properties in the ultra-violet regions.

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[1] Hotchkiss, R. D., *J. Biol. Chem.*, **175**, 315 (1948).
[2] Markham, R., and Smith, J. D., *Biochem. J.*, **45**, 294 (1949).
[3] Tennent, D. M., Whitla, J. B., and Florey, K., *Anal. Chem.*, **23**, 1749 (1951).
[4] Fisher, R. B., Parsons, D. S., and Morrison, G. A., *Nature*, **161**, 764 (1948).
[5] Hanes, C. S., and Isherwood, F. A., *Nature*, **164**, 1107 (1949).
[6] Briner, G. P., *J. Chromatography* (in the press).
[7] Drake, N. A., Haines, W. J., Knoff, R. E., and Nielson, E. D., *Anal. Chem.*, **28**, 2036 (1956).

Detection of Gentiobiose and Sophorose in Cultures of Certain Micro-organisms growing in Defined Glucose-containing Media

The ability of cellulose-forming species of *Acetobacter* to produce from glucose a mixture of melibiose, cellobiose, cellotriose, cellotetraose and fructose, together with higher oligosaccharides some of which yield fructose on hydrolysis, has been reported in recent communications[1–3]. We have now examined the behaviour, in comparable conditions, of *Acetobacter aceti* N.C.I.B. 8554, *Acetobacter rancens* N.C.I.B. 7214, *Acetobacter acidum-mucosum* N.C.I.B. 8133, and *Acetobacter acetosum* var. *nairobiense* N.C.I.B. 7212, none of which produces cellulose. *A. aceti* was grown in a medium containing (gm./l.): $(NH_4)_2SO_4$, 3; $MgSO_4.7H_2O$, 2; KH_2PO_4, 3; glucose, 30. The same ingredients with addition (gm./l.) of: DL-alanine, 0·1; asparagine, 0·1; calcium D-pantothenate, 0·002; riboflavin, 0·002 and biotin, 0·0003, were employed to make up the medium for the three other species. These media were dispensed in volumes of 200 ml. in sixteen Glaxo flasks, four flasks for each species. After inoculation and incubation for 10 days at 28° C. the contents of each set of four flasks were Seitz-filtered and concentrated to about 50 ml. in presence of a little barium carbonate *in vacuo* at 35°. Each concentrate was filtered and treated in the following manner in all four cases. It was added to a column (4·5 cm. diameter) filled with a charcoal–'Celite' (50 : 50, w/w) mixture. The column was eluted with water (5 l.) and then with aqueous ethanol solutions containing, respectively, 5, 15, 20 and 35 per cent (v/v) of ethanol. The aqueous ethanolic eluates were combined (4 l.), concentrated under low pressure at 35° C. to 500 ml. and treated successively with 'Zeo-Karb 225' (H^+ form) and 'De-Acidite *E*' (OH^- form).

After removal of these resins the solution was concentrated further to a syrup and examined in three ways by paper chromatography using: (*a*) *n*-propanol–water–ethyl acetate, 7 : 2 : 1 by vol.; (*b*) pyridine–water–ethyl acetate, 1 : 2 : 2 by vol.; and (*c*) the method of Bayly and Bourne[4], in which comparison is made of the benzylamine derivatives of sugars.

The chromatographic pattern afforded by the products of each species of *Acetobacter* was the same in all cases. Two disaccharides and one higher oligosaccharide predominated in each culture, and these disaccharides showed the mobilities of gentiobiose and sophorose, respectively, when run against authentic disaccharides by procedures *a*, *b* and *c*.

A. rancens was now employed in an experiment with 30 l. of medium. After incubation the metabolism solution was concentrated in presence of barium carbonate *in vacuo* at 35° C., filtered and subjected to charcoal–'Celite' treatment. The aqueous ethanolic eluates were combined, concentrated *in vacuo* at 35° C., desalted in the manner described by Walker and Wright[2] and oligosaccharides left in solution were separated by gradient elution from charcoal, following the technique of Bacon and Bell[5]. 95 fractions, each of 200 ml., were collected. From fractions 15–60 two reducing sugars were isolated, purified by band paper chromatography and examined in the solvents of *a*, *b* and *c*, in which they were indistinguishable from gentiobiose and sophorose, respectively. Also, on hydrolysis each yielded solely glucose, and on acetylation each yielded an acetate which on combustion gave values corresponding to $C_{28}H_{38}O_{19}$, the empirical formula for a disaccharide octa-acetate. Final confirmation of identity was obtained in each case by paper ionophoresis in borate buffer *p*H 10 at 800 V. for 3 hr.

In a study of glucose metabolism in *Aspergillus nidulans* Eidam, the mould was grown as surface cultures on a solution which contained (gm./l.): NH_4NO_3, 3·00; K_2SO_4, 0·22; $NaH_2PO_4.2H_2O$, 7·30; $MgSO_4.7H_2O$, 5·00; $FeCl_3.6H_2O$, 0·16; $ZnSO_4.7H_2O$, 0·05 and glucose, 100.

After 8 days at 26° the metabolism solution (20 l.) was filtered and concentrated in presence of a little barium carbonate at 35° to a thin syrup. This was subjected to charcoal–'Celite' chromatography to eliminate hexoses, as described by Bacon[6]. After removal of ethanol-insoluble salts of phosphoric acid esters[3] the oligosaccharide fraction was desalted with 'Zeo-Karb 225' and 'De-Acidite *E*', concentrated at

35°, and subjected to gradient elution with water and with aqueous ethanol from a charcoal–'Celite' column[7]. 96 fractions, each of 100 ml., were collected and contained three disaccharides and three higher oligosaccharides. Fractions 27–40, which contained principally disaccharides, were combined, evaporated to low bulk and resolved by cellulose column chromatography into three fractions containing two main components and a third component in traces. By band paper chromatography these two main components were isolated in pure condition. Each yielded only glucose on hydrolysis and each gave an acetate, $C_{18}H_{26}O_{13}$. By chromatographic procedures similar to those used for the products of the *Acetobacter* species and by ionophoresis in borate buffer *p*H 10 at 900 V. for 3 hr., the two disaccharides were shown to be gentiobiose and sophorose.

These results are of interest in relation to questions concerning cellulose synthesis by *A. acetigenum* and the formation of β-linked glucosaccharides by moulds. It is intended to report the work in more detail elsewhere.

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[1] Wright, H. B., and Walker, T. K., *Chem. and Indust.*, 18 (1955).
[2] Walker, T. K., and Wright, H. B., *Arch. Biochem. Biophys.*, **69**, 362 (1957).
[3] Steel, R., and Walker, T. K., *Nature*, **180**, 201 (1957).
[4] Bayly, R. J., and Bourne, E. J., *Nature*, **171**, 385 (1953).
[5] Bacon, J. S. D., and Bell, D. J., *J. Chem. Soc.*, 2528 (1953).
[6] Bacon, J. S. D., *Biochem. J.*, **57**, 320 (1954).
[7] Feingold, D. S., Avigad, G., and Hestrin, S., *Biochem. J.*, **64**, 340 351 (1956).

Malonate Metabolism by Plant Tissues

Interest in malonic acid has been largely directed towards its role as a competitive inhibitor of succinic dehydrogenase. Very little attention has been directed towards the occurrence of malonic acid in plant tissues or toward the metabolism of malonic acid *per se*. In 1952 Bentley[1] showed malonate to be present in about eighteen species of leguminous plants. Malonic acid has also been reported in species from families other than the legume family[1–3]. That malonic acid could be metabolized was established more than thirty years ago when it was shown that malonate could serve as the sole carbon source for certain bacteria[4]. More recent work established that malonate was readily metabolized by enzyme preparations from fungi[5,6], mammals[7,8], and plants[9,10]. The present communication reports a wide range of higher plants which possess the ability to metabolize malonate.

The procedure involved submerging the petiole of excised leaves into a vial containing 60 μmoles 2-^{14}C labelled malonate (specific activity = 1,000 c.p.m./μmole). The leaves were permitted to absorb the labelled malonate for 17 hr., at which time the leaves were oven-dried and the organic acids extracted with hot water. The organic acids were then separated by paper chromatography (ether/acetic acid/water, 4 : 1 : 5) and the individual organic acids counted on a gas-flow counter. The radioactivity in the individual organic acids (except malonate) was summed and the percentage of the total activity contributed by each acid calculated (Table 1). When radioactivity within an individual acid failed to exceed twice background, the percentage of the total count for that acid was listed as 'trace'.

Table 1. Percentage Contribution by Individual Acids toward Total Radioactivity in Organic Acid Fraction of Leaves following 17-hr. Absorption Period of 2-^{14}C Malonate through Leaf Petiole

Plant species	Malic	Citric	Succinic	Fumaric	Unidentified acids*
Lantana	30	17	9	6	38
Fig	26	10	7	*T*	54
Peach	24	9	11	*T*	55
Apple	39	8	*T*	*T*	50
Sweet orange	35	21	*T*	*T*	38
Eucalyptus	34	9	*T*	*T*	52
Coffee	13	14	*T*	*T*	64
Strawberry	45	15	*T*	*T*	34
Azalea	21	5	*T*	*T*	71
Walnut	26	*T*	14	*T*	45
Camellia	14	*T*	13	*T*	59
Soybean	35	*T*	24	*T*	30
Boysenberry	33	*T*	*T*	*T*	45
Corn	27	*T*	*T*	*T*	40
Tomato	46	*T*	*T*	*T*	40

* Unidentified acids, usually three or four in number, were situated near the origin and in most cases were poorly resolved.
T, Trace (radioactivity failed to exceed twice background).

Table 1 lists the percentage radioactivity present in individual organic acids following a 17-hr. absorption period of 2-^{14}C malonate through the leaf petiole. The presence of radioactivity in organic acids indicated that malonate was metabolized and that the No. 2 carbon was incorporated into various acids. Comparing the radioactivity among the isolated acids, it may be noted that malate in each case contained the largest percentage of radioactivity, followed in most cases by citrate, succinate, and fumarate, respectively. Substantial quantities of radioactivity were also present in several unidentified acidic constituents possessing quite low R_F values. Identification of these acidic constituents is incomplete.

The fifteen plant species which are listed in Table 1 were selected at random from forty-five species examined. The thirty unlisted species follow: acacia, almond, blackeye pea, bougainvillea, bush bean, cactus, cherimoya, eugenia, feijoa, fuschia, geranium, hydrangea, ivy, loquat, morello cherry, mustard, natal plum, papaya, passion fruit, pear, persimmon, poinsettia, potato, rose, rough lemon, sunflower, trifoliate orange, tropical guava, white sapote, and wing nut. Substantial radioactivity was detected in one or more of the Krebs cycle acids in each species examined.

Working with particulate enzyme preparations, Young and Shannon[10] recently suggested that the pathway of malonate metabolism in bush bean leaves proceeded according to the following scheme:

$$\text{malonate} \longrightarrow \text{malonyl coenzyme } A \longrightarrow \text{acetyl coenzyme } A$$

The product of this reaction scheme, acetyl coenzyme *A*, was then available for condensation with oxalacetate and subsequent oxidation by the Krebs cycle. While only respiratory reactions were investigated, it was suggested that the product, acetyl coenzyme *A*, participated in other reactions as well. Brady[11] reported recently that malonyl coenzyme *A* was an active participant in fatty acid synthesis.

The radioactive assay results indicated that forty-five species, comprising twenty-seven families, incor-

porated the No. 2 carbon of malonate into one or more of the identified acids—malate, citrate, succinate, or fumarate. In view of the large number and diversity of species performing this incorporation, it is suggested that the enzyme(s) capable of metabolizing malonate may be widespread throughout the plant kingdom.

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[1] Bentley, L. E., *Nature*, **170**, 847 (1952).
[2] Nelson, E. K., and Hasselbring, H., *J. Amer. Chem. Soc.*, **53**, 1040 (1931).
[3] Young, R. E., and Biale, J. B., *Plant Physiol.*, **31** (Supp.), 23 (1956).
[4] den Dooren de Jong, L. E., Dissertation, Rotterdam (not seen) (1926).
[5] Hayaishi, O., *J. Biol. Chem.*, **215**, 125 (1955).
[6] Wolfe, J., Iuler, D., and Rittenberg, S., *J. Biol. Chem.*, **209**, 867 (1954).
[7] Nakada, H., Britton, B., and Wolfe, J., *Fed. Proc.*, **16**, 93 (1957).
[8] Nakada, H., Wolfe, J., and Wick, A., *J. Biol. Chem.*, **226**, 145 (1957).
[9] Giovanelli, J., and Stumpf, P. K., *Plant Physiol.*, **32**, 498 (1957)
[10] Young, R. H., and Shannon, L. M., *Plant Physiol.*, **33** (Supp.), 35 (1958).
[11] Brady, R. O., *Proc. U.S. Nat. Acad. Sci.*, **49**, 933 (1958).

Micro-volume Drop-plate Assay of Antibiotics

In assaying antibiotic substances by any of the well-known plate diffusion methods it is necessary to dilute the unknown solution to varying degrees, depending on the original concentration. In addition to minimizing the possible disturbing influence of interfering substances and the *p*H of the original sample in the assay plate, this procedure has the practical convenience of providing inhibitory zones of a suitable size-range needed for a satisfactory assay. However, if one could run good assays on the original concentrated samples without resorting to serial dilution it would simplify the assay procedures. We have found that such a step is possible with the use of a micrometer syringe which would enable one to spot micro-volumes directly on the assay plate with great accuracy. These minute volumes dry rapidly and form discrete spots, giving uniformly circular inhibition zones after allowing proper diffusion and incubation periods.

In order to test the practicability of the outlined approach, several four-point assays were run on liquid samples containing penicillin by both the conventional cup-method and the micro-volume drop-plate method, the latter with the aid of a micrometer syringe ('Agla' brand, Burroughs Wellcome and Co.). In both cases the plates were prepared according to the enriched seed layer method described by the U.S. Food and Drug Administration[1], using 'Difco Penassay' base and seed agars. The assay organism was *Bacillus subtilis* A.T.C.C.6633. In the droplet method, in place of cups, the same volumes of a suitable penicillin *G* standard and the unknown—usually, 0·4 and 1·6 µl., corresponding to two and eight small divisions on the peripheral scale of the micrometer head—were spotted directly on the agar surface. Assay values were calculated from the resulting inhibition zones using Miyamura's nomogram[2].

Results of the assays given in Table 1 show that the droplet method as used by us is quite satisfactory, and the errors involved cannot be considered to be higher than in the commonly used cup, cylinder and bead-modifications of the plate assays. In our experience, the method is simpler than these other conventional plate methods and less time-consuming,

Table 1. Penicillin Titres of Unknowns in Units/Ml.

Sample No.	Cup-plate assay	Micro-volume drop-plate assay
1	1,020	1,010
2	2,020	2,000
3	2,180	2,390
4	1,860	1,840
5	1,910	2,050
6	1,740	1,700
7	2,180	1,940
8	1,598	1,557
9	1,650	1,683

as highly concentrated unknowns can be used directly in the assay plate. The method has no material disadvantages except, perhaps, the increased concentration and care required of the operator while adding small volumes represented by one or two small divisions on the peripheral scale of the micrometer head. However, with the addition of a semi-automatic addition mechanism such as the one described earlier[3], this method is capable of being developed into a good routine tool for assaying not only antibiotics but also other compounds which are physiologically active in agar plate methods involving micro-organisms or cell-lines.

Further evaluation of the method is being published in detail elsewhere.

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[1] "The Compilation of Tests and Methods of Assay for Antibiotic Drugs", U.S. Federal Security Agency, Food and Drug Administration, 1 (1954).
[2] Miyamura, S., *Antibiotics and Chemotherapy*, **6**, 658 (1956).
[3] Glynn Jones, G. D., and Lowe, H., *J. Lab. Practice*, **5**, 69 (1956).

Incidence of the Erythrocytic Defect associated with Drug-Sensitivity among Oriental Subjects

In the past few years a new type of metabolic lesion of the red cell has been elucidated. It was found that sensitivity to the hæmolytic action of the 8-aminoquinoline primaquine and many other compounds was due to an intrinsic defect of the red cell[1]. This defect can be demonstrated *in vitro* by: (1) incubating the red cells with a solution of acetylphenylhydrazine and observing the pattern of Heinz body formation[2], and (2) incubating the red cells with acetylphenylhydrazine or a number of other substances and measuring the level of reduced glutathione after an incubation period of 2 hr. (the glutathione stability test)[3], or (3) measuring the activity of the enzyme glucose-6-phosphate dehydrogenase in the red cells[4].

It has been known for some time that sensitivity to drug-induced hæmolysis varies considerably in different racial groups. Application of these *in vitro* techniques has disclosed marked differences in the incidence of this red-cell defect in various population groups. Thus, the defect is common in American Negroes, but rare in most Caucasian populations. It is relatively common in Sardinia, and in Israel has been found to occur commonly in Sefardic, but not in Aschkenazy Jews. As might be expected, the incidence of drug-induced hæmolytic anæmia and favism

(which occurs only in individuals with this red-cell defect) is highest in those groups that have a high incidence of the red-cell defect as demonstrated by *in vitro* means. Available data regarding incidence and distribution of this defect, as elucidated by many authors, have been reviewed recently[5].

Several cases of fava bean-[6], 8-aminoquinoline-[5], and naphthalene-induced hæmolytic anæmias[7] in oriental people have been reported in the literature, but the incidence of this red-cell defect in this race has not been determined. For this reason, we have applied the glutathione stability test to 99 subjects of oriental origin, mostly students, all residing in the United States. The test was carried out exactly as described originally by one of us, except that 1 ml. of acid-citrate-dextrose solution was used as anticoagulant per 5 ml. of whole blood. This permits cold storage of blood samples for as long as 3 or 4 weeks before the test is performed[8]. In the studies described here, the test was always performed within 10 days of the time the blood was drawn. In the case of the single positive reactor detected, the test was repeated with a freshly drawn sample of blood, both with heparin and acid-citrate-dextrose solution used as anticoagulant. The test for sensitivity using Heinz bodies was carried out as described previously[3]. The assays for glucose-6-phosphate dehydrogenase and 6-phosphogluconate were carried out by means of a slight modification of the method described by Marks[9].

The results of studies on the stability of glutathione are given in Table 1. The red cells of all subjects tested contained more than 37 mgm. per cent reduced glutathione after incubation with acetylphenylhydrazine except for the one positive Thai subject. His red cells contained 15 mgm. per cent reduced glutathione after incubation with acetylphenylhydrazine. In the case of the positive reactor, an assay for glucose-6-phosphate dehydrogenase showed that only 4·0 units/gm. of hæmoglobin were present, as compared with a mean normal of 15·9 units/gm. of hæmoglobin as reported by Marks[9]. 6-Phosphogluconic dehydrogenase activity was normal. The Heinz body pattern, after incubation with acetylphenylhydrazine, was typical of drug-sensitive red cells.

Table 1. Place of Origin of Ancestors of 99 Oriental Subjects Tested

Place of origin	Sex	Number tested	Positive test
Total Chinese	M	41	0
	F	36	
By Province:			
Chekiang	M	2	0
	F	5	
Fukien	M	5	0
	F	4	
Hopei	M	0	0
	F	2	
Hunan	M	1	0
	F	0	
Kiangshu	M	4	0
	F	1	
Kwantung	M	18	0
	F	23	
Shantung	M	1	0
	F	0	
Szechuan	M	1	0
	F	0	
Unclassified	M	9	0
	F	1	
Burma	M	1	0
	F	1	
Thailand	M	8	1
	F	1	0
Japanese	M	6	0
	F	2	
Korean	M	2	0
	F	0	

The observations presented here are too limited in scope to allow us to draw any quantitative conclusions about the incidence of this defect in oriental populations. It would seem, however, that while this defect does exist among oriental people, the incidence among at least one group, the Chinese, is low.

The co-operation of Drs. S. Larsh and V. Minnich in obtaining blood samples from Thai subjects and of Dr. W. T. Wong in obtaining samples from Chinese subjects, is greatly appreciated.

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[1] Dern, R. J., Weinstein, I. M., LeRoy, G. V., Talmage, D. W., and Alving, A. S., *J. Lab. Clin. Med.*, **43** (2), 303 (1954).
[2] Beutler, E., Dern, R. J., and Alving, A. S., *J. Lab. Clin. Med.*, **45**, 40 (1955).
[3] Beutler, E., *J. Lab. Clin. Med.*, **49**, 84 (1957).
[4] Carson, P. E., Flanagan, C. L., Ickes, C. E., and Alving, A. S., *Science*, **124**, 484 (1956).
[5] Beutler, E., *Blood*, **14**, 103 (1959).
[6] Swun-deh Du, *Chinese Med. J.*, **70**, 17 (1952).
[7] Cock, T. C., *Amer. J. Dis. Children*, **94**, 77 (1957).
[8] McGovern, J. J., Isselbacher, K., Rose, P. J., and Grossman, M. S., *Amer. J. Dis. Children*, **96**, 502 (1958).
[9] Marks, P. A., *Science*, **127**, 1338 (1958).

Taurine in Human Blood Platelets

Morita and Asada[1] have shown a considerable amount of taurine and other sulphur compounds to be present in the platelets of human blood. We have attempted to determine the level of taurine in platelets and the probable metabolic pathway of its formation.

The suspension of platelets was obtained from the blood of healthy humans. The blood was mixed with 5 per cent solution of ethylenediamine tetraacetic sodium salt (10 : 1), and centrifuged many times. The suspension usually contained 2,000,000–3,000,000 platelets/c.mm. counted by the Rees–Ecker method. The contamination by erythrocytes and leucocytes did not exceed 0·1 per cent. The platelets obtained in this manner showed metabolic activity for more than 10 hr. when their oxygen consumption was investigated in Cartesian divers. In the course of investigation the platelets were suspended in physiological solution with an addition of phosphate buffer *p*H 7·3. For quantitative estimation of taurine, 0·3 ml. of the platelet suspension was cytolysed by quick freezing and thawing followed by incubation with a drop of toluene[2] for 20 min. The cytolysate was passed through a column of 'Zeo-karb 225' in the acid form. In these conditions the resin retains the salts and amino-acids, and the taurine and cysteic acid pass through quantitatively into the filtrate[3]. The filtrate was evaporated to dryness and dissolved in 0·2 ml. of redistilled water. A 15-μl. sample was applied eccentrically on a Whatman No. 1 paper disk, and circular chromatography was run for 15 hr. in water–butanol–acetic acid solvent (5 : 4 : 1). The spots were detected by staining with ninhydrin[4]. The quantitative estimation was performed by extinction measurements of the eluate from paper using a Coleman or Hilger spectrophotometer. The error of this method was found to be ± 3·3 per cent.

For investigation of the formation of taurine in the platelets, the suspensions were incubated with 0·02 *M* solutions of cysteine or cysteic acid for 15 hr. in air or nitrogen atmosphere. After incubation the samples were cytolysed and the taurine was estimated as described above. In each experiment the level of taurine was compared with the content of this compound in the platelets from the same specimen of blood without incubation (blank).

We have examined platelets from the blood of 21 normal persons. We have found that the amount of taurine per platelet varies in different persons between $6·2 \times 10^{-8}$ μgm. and $9·8 \times 10^{-8}$ μgm.; in most cases it was more than $8·0 \times 10^{-8}$ μgm. Recalculated per unit of wet weight, this gives a value of 1·5 mgm. of taurine per gm. of platelets.

In the platelets incubated with cysteic acid we have sometimes found a small increase in the amount of taurine. The amount of cysteic acid in the suspension fluid always decreases during the experiment. After incubation of the platelets with cysteine, an increase of about 20–40 per cent in the taurine content was shown in all experiments. If parallel incubations were carried out of two samples at the same time, one with cysteic acid and the other with cysteine, we always found a greater increase in the amount of taurine in the sample with cysteine. An example of a typical experiment is given in Table 1.

Table 1

Suspension of platelets	Preparation of sample	Results (μgm.)	
		Taurine	Cysteic acid
Blood group O 2,600,000 platelets/c.mm. 1,100 erythrocytes/c.mm. 700 leucocytes/c.mm.	Blank platelets cytolysed and denatured + cysteic acid and cysteine	4·3	68
	Sample I platelets incubated 15 hr. in air with cysteine	6·3	trace
	Sample II platelets incubated 15 hr. in air with cysteic acid	5·0	60

We confirmed the production of taurine in the platelets by using cysteine labelled with sulphur-35. The spot of taurine from platelets was radioactive when the suspension was incubated with labelled cysteine.

These results show that in the blood platelets of normal persons the taurine-level is constant. Taurine is produced in the platelets, and cysteine is a better substrate for its formation than cysteic acid. This fact suggests that the taurine in human platelets is formed from cysteine through cysteine sulphinic acid and hypotaurine. Therefore, the mechanism of taurine formation in human platelets resembles that described by Bergeret *et al.*[5] and Awapara[6] in rats.

Further investigations are in progress.

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[1] Morita, H., and Asada, T., *Le Sang*, **9**, 827 (1957).
[2] Koppel, J. L., and Olwin, J. H., *Proc. Soc. Exp. Biol. Med.*, **86**, 641 (1954).
[3] Prior, A. P., and Whitehead, T. P., *Nature*, **172**, 358 (1953).
[4] Kay, R., and Harris, D., *Arch. Biochem. Biophys.*, **63**, 14 (1956).
[5] Bergeret, B., Chatagner, F., and Fromageot, C., *Biochim. Biophys. Acta*, **9**, 147 (1952).
[6] Awapara, J., *J. Biol. Chem.*, **203**, 183 (1953).

Detection of Antigens as Specific Precipitates on Paper Electrophoresis Strips

Agar diffusion[1] has been used for detecting antigens after paper electrophoresis. I have found that a precipitin reaction can be carried out directly on the paper.

After electrophoresis, a strip of paper dried at room temperature is placed in contact with filter paper previously moistened with sufficient antiserum to saturate the applied paper. The papers are left in a closed container for 2–4 hr. The electrophoresis strip is then removed and immersed in 0·9 per cent (w/v) sodium chloride for several minutes if Whatman No. 1 paper is used, or overnight for Whatman No. 3 *MM* paper. Nine further washings of 1 min. each are sufficient to remove excess antiserum. The washed strip is dried and stained with bromphenol blue[2]. Specific precipitates appear as dark blue spots on a light blue background.

The method has been applied to the demonstration of a serum protein antigen after electrophoresis in a veronal–borate buffer and of a polysaccharide from *Mycoplasma mycoides*[3] (Fig. 1). The polysaccharide has been detected after electrophoresis in 0·05 *M* acetate, veronal and borate buffers over the range of *p*H 4–11.

The following points should be noted: (1) Large amounts of antigen may yield spots with white centres due to local antigen excess. (2) Intensity of spot colour may not be proportional to the amount of antigen present. Partially overlapping spots may not be distinguishable. (3) Irreversibly adsorbed protein, present before application of serum, may cause artefacts.

While this work was proceeding, a method of detecting antigens on paper by simultaneous electrophoresis of antigen and serum[4] was published.

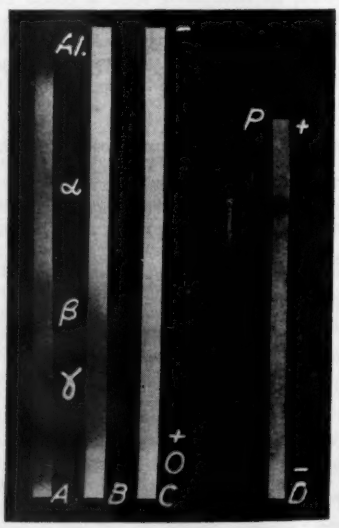

Fig. 1. *A*, *B*, *C*, bovine serum 0·01 ml./5 cm. width paper, applied at origin *O*. Electrophoresis in veronal borate *p*H 8·6. *A*, untreated, stained; *B*, treated with anti-γ-globulin serum, washed and stained; *C*, treated with control serum, washed and stained. *Al*, *α*, *β*, *γ* represent albumin, *α*-, *β*- and γ-globulins respectively. *D*, 10 μgm. *M. mycoides* polysaccharide applied at *P*. Electrophoresis in 0·05 *M* borate *p*H 11. Treated with immune serum, washed and stained

I wish to thank Dr. A. W. Rodwell and Mr. P. Plackett for their advice and support.

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[1] Grabar, P., and Williams, C., *Biochim. Biophys. Acta*, **17**, 67 (1955).
[2] Formusa, K. M., Benerito, R. R., Singleton, W. S., and White, J. L., *Analyt. Chem.*, **29**, 1816 (1957).
[3] Plackett, P., and Buttery, S., *Nature*, **182**, 1236 (1958).
[4] Nakamura, S., and Ueta, T., *Nature*, **182**, 875 (1958).

Changes in *p*H and Temperature in Poultry Breast Muscles at Slaughter

During a study of factors which might affect the tenderness of poultry meats, some observations were made on the changes in *p*H and temperature occurring in the breast muscle of birds during and after slaughter.

Needle electrodes (Beckman No. 40470) and a thermocouple were tied into the muscle prior to slaughter. The thermocouple was connected to a recorder and the temperature was automatically recorded at ½-min. intervals. *p*H readings were made every 30 sec. during the first 5 min. or so and then at 2- or 5-min. intervals, depending on the rate of fall of the *p*H.

The birds were slaughtered in a manner simulating commercial practice, that is, they were suspended head down and the throat cut. This procedure leads to a rapid bleeding.

Chickens, turkeys and geese were examined.

In all the types of birds examined there was a rise in temperature within 5 min. of the throat being cut, followed by a slow fall. In chickens and turkeys this was most marked, as is shown in Fig. 1, in some cases being as much as 3·5° F. The rise in geese was not as marked and in no case exceeded 1° F. This rise is probably due to continued work by the muscle in the absence of the heat-regulating power of the blood. Chicken and turkey breast muscles are 'white' meats, whereas goose breast muscle is a 'dark' meat. It would appear that there is a definite difference in the temperature reaction of these two types of muscles.

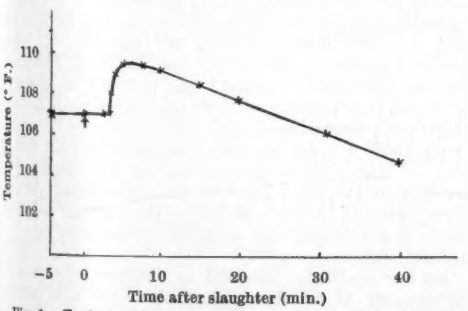

Fig. 1. Typical temperature response of turkey breast muscle after slaughter

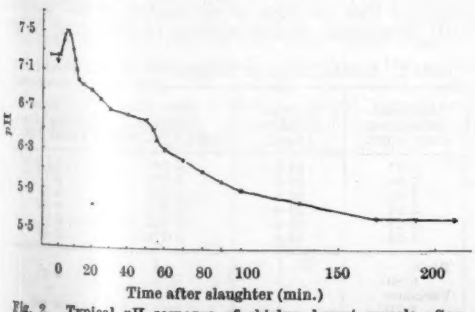

Fig. 2. Typical *p*H response of chicken breast muscle after slaughter

Also, in all the types of poultry examined there was at first a rise in *p*H followed by a gradual stepwise decline as is shown in Fig. 2.

Table 1 gives the mean and range *p*H and temperature rises.

Table 1

Type of bird	No. of birds	Mean *p*H rise	Mean temperature rise (° F.)
Chicken	15	0·20 (0·05–0·30)	1·0 (0·0–2·0)
Turkey	5	0·25 (0·05–0·50)	2·1 (1·00–3·50)
Goose	6	0·15 (0·05–0·25)	0·55 (0·25–0·75)

(Figures in brackets are the range)

Reports by Bate-Smith and Bendall[1] and Scaife[2] on the changes in *p*H occurring in beef and pork muscle after slaughter make no mention of the rise in *p*H that was observed in these studies. This may be due to the initial *p*H being defined (Bate-Smith[1]) as "the *p*H of the muscle within 5 minutes of slaughter". In most cases it was found that the *p*H had already begun to decline 5 min. after slaughter.

A full report of this work will be published elsewhere.

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[1] Bate-Smith, E. C., and Bendall, J. R., *J. Physiol.*, **110**, 47 (1949).
[2] Scaife, J. F., *J. Sci. Food Agric.*, **6**, 467 (1955).

Relaxation of Glycerol-treated Muscle Fibres by Acetone

Certain sulphydryl reagents such as 'Salyrgan'[1] and certain chelating agents such as ethylenediamine tetraacetate[2,3] have been known to have a lengthening action on glycerinated muscle fibres in the presence of adenosine triphosphate. A reasonable explanation of this relaxing action by 'Salyrgan' has already been given[1]. The chelating actions of ethylenediamine tetraacetate and its analogues are of interest. We have reported[4], however, using seven different chelating agents, that their chelating activities were not parallel with their relaxing capacities. Thus the mechanism of these agents remains unsolved.

It was found that acetone had a reversible relaxing action on glycerinated fibres, like ethylenediamine tetraacetate and 'Salyrgan' (Fig. 1). The concentration of acetone required was rather high, but the action was not due to the non-specific effect of high concentration of non-electrolyte, because sucrose and glycerol were quite ineffective in much higher concentration. Acetylacetone and ethyl acetate, especially the latter, were much more effective than acetone, but they were not so complete as acetone in their

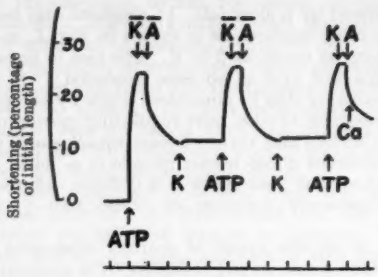

Fig. 1. Extension effect of acetone in the presence of adenosine triphosphate. *K*, 0·15 *M* potassium chloride solution containing 0·01 *M* magnesium chloride and 0·02 *M* *tris*-(hydroxymethyl)-aminomethane-maleate buffer (*p*H 6·8); $\overline{K}$, *K* without magnesium chloride. ATP, 5 m*M* adenosine triphosphate in *K*. *A*, 10 per cent acetone by volume and 5 m*M* adenosine triphosphate in *K*. $\overline{A}$, 10 per cent acetone by volume and 5 m*M* adenosine triphosphate in $\overline{K}$. Ca, calcium chloride added; final concentration, 8 m*M*

reversibility. Dioxane was also prominent in producing extension, but the fibres lost their contractility completely.

Acetone by itself had little plasticizing action and did not have a significant effect on the adenosine triphosphatase activity of muscle fibres or actomyosin. In the presence of inorganic pyrophosphate or tripolyphosphate, however, acetone exerted a strong relaxing action on fibres without affecting their contractility (Fig. 2). In other words, acetone accelerated remarkably the plasticizing action of pyrophosphate or tripolyphosphate. This suggests that acetone lengthens muscle fibres by enhancing the plasticizing action of adenosine triphosphate.

The effects seem almost the same for ethylenediamine tetraacetate and its analogues as for acetone (Fig. 2). It would be premature, however, to conclude that these facts also explain the mechanism of ethylenediamine tetraacetate relaxation, because the contractility of fibres treated by both ethylenediamine tetraacetate and pyrophosphate was scarcely restored, that is, the relaxation was not reversible. Further studies are needed in this case.

In contrast to these reagents, 'Salyrgan' and *p*-chloromercuribenzoate showed only a little, if any, accelerating action on the action of pyrophosphate. Granules in skeletal muscle[5,6], which are now accepted as the essential relaxing factor, also did not enhance the plasticizing action of pyrophosphate.

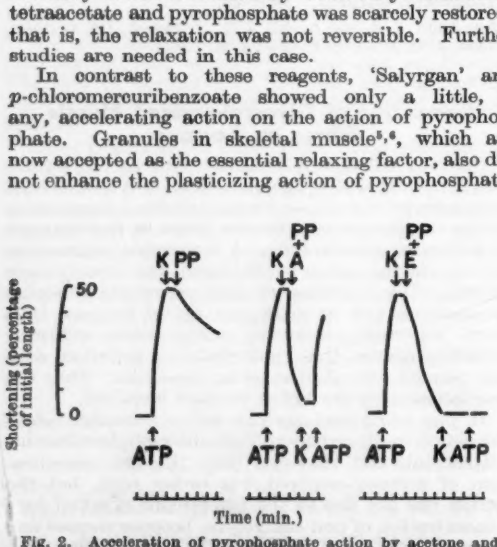

Fig. 2. Acceleration of pyrophosphate action by acetone and ethylenediamine tetraacetate. *PP*, 1 m*M* pyrophosphate in *K* (Fig. 1); *PP* + *A*, 1 m*M* pyrophosphate and 10 per cent acetone by volume in *K*; *PP* + *E*, 1 m*M* pyrophosphate and 1 m*M* ethylenediamine tetraacetate in *K*; *K* and ATP, similar to Fig. 1 but at *p*H 6·6

These observations suggest that there are different kinds of mechanisms for relaxation of glycerol-treated muscle fibres. Further details will be published elsewhere.

We wish to thank Prof. H. Kumagai for his encouragement, and also Dr. S. Watanabe for discussions.

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[1] Portzehl, H., *Z. Naturforsch.*, **7b**, 1 (1952).
[2] Bozler, E., *J. Gen. Physiol.*, **38**, 149 (1954).
[3] Watanabe, S., *Arch. Biochem. Biophys.*, **54**, 559 (1955).
[4] Ebashi, S., Ebashi, F., and Fujie, Y., *J. Biochem.* (*Japan*) (in the press).
[5] Kumagai, H., Ebashi, S., and Takeda, F., *Nature*, **176**, 166 (1955).
[6] Ebashi, S., *Arch. Biochem. Biophys.*, **76**, 410 (1958).

Effect of the Rate of Elimination of Digoxigenin in the Guinea Pig on the Determination of its Lethal Dose

When a drug is given by intravenous infusion it is not possible to define its lethal dose if it is detoxified rapidly, because the apparent lethal dose will depend on the rate of administration of the drug. This difficulty has been emphasized by Beccari[1], who pointed out that in the case of drugs which are rapidly eliminated it is better to define a 'lethal rate' of infusion rather than a lethal dose. The problem of deciding at which rate of infusion to determine the lethal dose has always been apparent in the study of cardiac glycosides, and has been accentuated by the earlier need for biological assay of these drugs. The relationship between rate of infusion and lethal dose of cardiac glycosides and aglycones is complex, depending both on the individual drugs and the species used for the determination of toxicity. In the British Pharmacopœia (1958) and the U.S. Pharmacopœia (thirteenth revision) this problem is defined by laying down maximum and minimum times during which each determination of lethal dose must be made. From Table 1 it can be seen that the apparent lethal dose of digoxigenin determined in the guinea pig depends on the time taken to produce death. At the lower rates of infusion in which the time to produce death is prolonged, the apparent lethal dose has the highest values.

Earlier methods designed to measure the rate of elimination of cardiac glycosides[2,3] did not permit any investigation of the effect of dose on the rate of elimination of these drugs, although it would be expected that the rate of elimination would increase with increasing concentrations of the drug in the

Table 1. Lethal Doses of Digoxigenin in the Guinea Pig

Apparent lethal dose (mgm./kgm.)	Time of infusion (min.)	Rate of infusion (mgm./kgm./min.)	True lethal dose (mgm./kgm.)
9·97	48·6	0·205	5·12
7·78	28·8	0·270	5·13
7·67	26·0	0·295	5·27
5·51	18·0	0·306	4·22
5·28	18·0	0·293	4·10
4·58	16·6	0·276	3·58
Mean 6·80			4·57
Variance 4·10			0·485

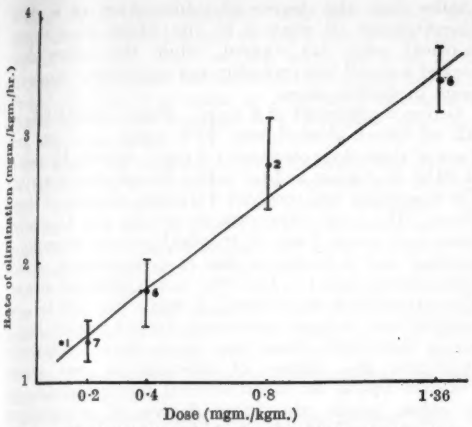

Fig. 1. The relationship between the dose of digoxigenin and its rate of elimination in the guinea pig. The figures beside the points indicate the number of observations at each dose, and the standard errors of these observations are represented by the vertical lines

animal's tissues. By using the method of determining the duration of action of cardiac glycosides described previously[4] it has been possible to establish the relationship between the dose of digoxigenin given and its rate of elimination in the guinea pig. In this method, injections of a suitable dose of adenosine are given regularly at 2-min. intervals. The responses of heart block are recorded on an electrocardiogram, and the duration of each response is measured. After an intravenous injection of digoxigenin the responses to adenosine are at first more prolonged and then gradually this potentiation decreases. The duration of action of digoxigenin is taken as the time during which the responses to adenosine remain potentiated. Fig. 1 shows the effect of increasing dose-levels of digoxigenin upon its rate of elimination by the guinea pig. This graph is based on 22 observations from 12 guinea pigs. The line drawn on the graph is the calculated regression line giving the best fit to the data. Measurements have been made with doses of digoxigenin up to 20 per cent of the dose which kills the guinea pig when infused during 15–30 min., and it is not feasible to administer larger doses in a single injection. The mean rate of elimination of digoxigenin was 1·87 mgm./kgm./hr. per mgm./kgm. For the purpose of the following calculation, it has been assumed that this relationship holds with higher doses of digoxigenin. This figure can then be used in conjunction with experimental results of rates of infusion of digoxigenin and the times to death to calculate the amount of drug actually present in the animal at the time of death, that is, the 'true' lethal dose.

Let D = dose-level actually present in the animal (amount given less the amount eliminated, mgm./kgm.); x = rate of infusion (mgm./kgm./min.); y = rate of elimination (mgm./kgm./min. per mgm./kgm.); = time after start of infusion (min.).

Then:

$$\frac{\mathrm{d}(D)}{\mathrm{d}t} = x - yD$$

$$\int \frac{\mathrm{d}(D)}{x - yD} = \int \mathrm{d}t$$

$$-\frac{1}{y}\log(x - yD) = t + C \qquad (1)$$

When $t = 0$, $D = 0$, and $C = -\frac{1}{y}\log x$

Substituting in (1) and rearranging:

$$D = \frac{x - \exp(-yt + \log x)}{y}$$

From this formula the 'true' lethal dose of digoxigenin (D) has been calculated for each of the six guinea pigs which received continuous infusions of digoxigenin until death, using the data shown in Table 1. It can be seen that the mean dose of digoxigenin infused into the guinea pig to produce death is about 1½ times the mean amount actually present in the guinea pig at the moment of death. If the scatters of the observations of the apparent lethal dose and of the true lethal dose about their respective means are examined it can be seen that the variance is considerably less when correction has been made for the amount of digoxigenin which has been eliminated during the course of the determination of lethal dose, and this reduction is statistically significant ($F = 8{\cdot}22$, $P < 0{\cdot}05$).

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[1] Beccari, E., *Arch. intern. Pharmacodyn.*, **73**, 65 (1946).
[2] Hatcher, R. A., *Arch. int. Med.*, **10**, 268 (1912); *J. Amer. Med. Assoc.*, **61**, 386 (1913).
[3] Hauptstein, P., *Arch. Exp. Path. Pharmak.*, **126**, 121 (1927).
[4] Rand, M., and Stafford, A., *Nature*, **177**, 278 (1956).

Triiodothyronine in Acute Alcoholic Intoxication

Reports in the lay press of the sobering effect of triiodothyronine in intoxicated humans suggested to us the desirability of investigating the effect of this compound on acute alcoholic intoxication under controlled conditions in the laboratory. To this end varying doses of triiodothyronine (3,3′,5-triiodo-L-thyronine as either the free acid or the sodium salt, obtained from Sigma Chemical Co.) were administered intraperitoneally to normal female dogs of 10–15 kgm., after which a dose of 3·0 gm. per kgm. of ethyl alcohol, diluted to 15 per cent with normal saline, was administered intravenously over a period of about 30 min. At the end of 1 hr. after the start of the injection, and afterwards each hour for 7 hr., samples of venous blood were drawn for alcohol analyses[1] and the degree of intoxication assessed according to an arbitrary scale of 10 stages used for many years in this laboratory[2]. Controls were run on each animal, varying only in the absence of the injection of triiodothyronine.

The initial concentration of alcohol in the blood less the concentration at the end of the experiment, divided by the time-interval, gave the rate of disappearance of alcohol from the blood-stream, expressed in mgm. per 100 ml. per hr., which is a reliable index of the rate of alcohol metabolism. The degree of intoxication plotted against the concentration of blood alcohol yielded a curve that made it possible by interpolation to estimate the degree of intoxication at each decrement of 20 mgm. per 100 ml. This device enabled us to average the degree of intoxication at a given blood alcohol-level for a group of dogs.

Two groups of dogs were used, with some of the animals common to the two groups. All had been

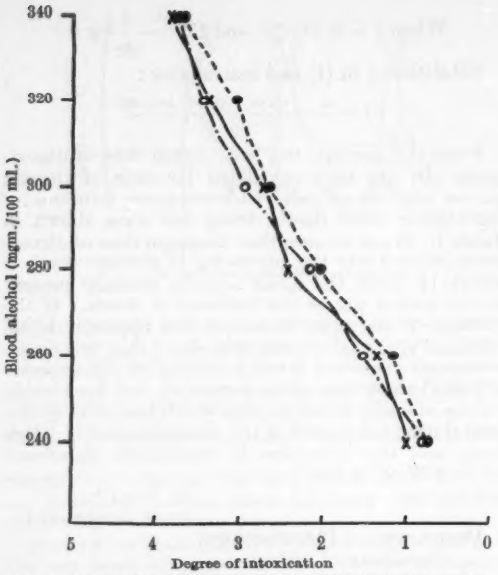

Fig. 1. Degree of intoxication at a given blood alcohol concentration in the same group of 4 dogs with and without pre-medication with triiodothyronine. ×—×, Control; ○—○, triiodothyronine 250 μgm; ●--●, triiodothyronine 375 μgm.

in the laboratory more than three months, and had received numerous similar alcohol injections at intervals of not less than one week. Group 1 consisted of 4 dogs. Their average rate of fall in concentration of blood alcohol on control runs was 20·9 mgm. per 100 ml. blood per hr. When 250 μgm. triiodothyronine were administered to the same dogs 30 min. before the alcohol injection the rate was 19·3, while with 375 μgm. triiodothyronine it was 19·1, an insignificant difference. Fig. 1 shows that with the smaller dose the degree of intoxication at a given concentration of alcohol in the blood was almost identical with the control, while the larger dose evoked a small but probably not significant improvement in performance.

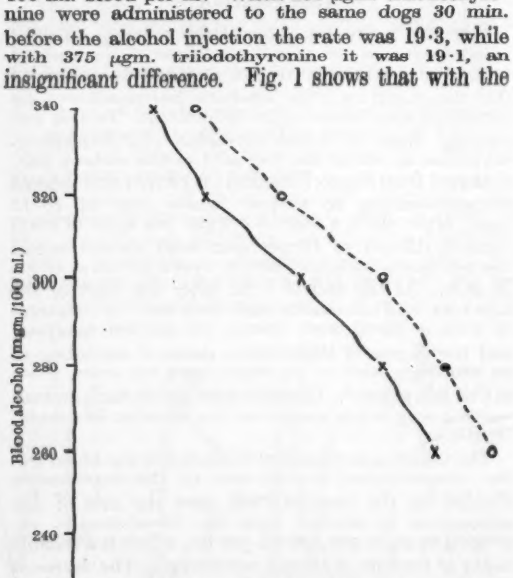

Fig. 2. Degree of intoxication at a given blood alcohol concentration in the same group of 6 dogs with and without pre-treatment with triiodothyronine 2·5 or 5·0 mgm. at 20 hr., and again 30 min. before administration of alcohol. ×—×, Control; ○--○, triiodothyronine

Group 2 consisted of 6 dogs. Their control rate of fall of blood alcohol was 20·9 mgm. per 100 ml. Four of these dogs received 2·5 mgm. triiodothyronine at 20 hr. and again at ½ hr. before the alcohol injection. The remaining two received 5·0 mgm. at each of these times. The only symptoms shown by the dogs after these very large doses of triiodothyronine were some panting and a transient rise in temperature of not more than 1 deg. C. The rate of fall of blood alcohol after triiodothyronine was 21·3 mgm. per 100 ml., an insignificant increase over their control value. Fig. 2 shows that with these very large doses of triiodothyronine the degree of intoxication was about 1 degree less at all blood alcohol concentrations, or, in other words, the same degree of intoxication occurred at a blood alcohol concentration about 20 mgm. per 100 ml. higher than in the control runs.

The small but significant reduction in the degree of intoxication brought about by triiodothyronine would indicate, if applied to man, that about one more drink could be consumed before reaching a given degree of drunkenness. If the dog and man show a comparable response to triiodothyronine, the effective dose for man would be in the vicinity of 12·5–25 mgm., which is much in excess of any reported dose. The possibility of species difference would indicate the desirability of repeating the work with human subjects, using maximal safe doses of triiodothyronine.

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[1] Newman, E. J., and Newman, H. W., *Stanford Med. Bull.*, 11, 96 (1953).
[2] Newman, H. W., and Lehman, A. J., *J. Pharmacol. and Exp. Therap.*, 62, 301 (1938).

Adrenal Cortical Function in the Pregnant Sheep

Relatively little is known regarding the role of the adrenal cortex in human pregnancy. Conflicting reports appear in the literature on steroid excretion-rates in women during normal pregnancy. Some workers[1] have found no change in 17-ketogenic steroid excretion in the last trimester of pregnancy, while others[2], using the same chemical method for their estimation, report a slight increase in levels. In contrast, Venning[2], employing a bioassay technique as a measure of adrenal activity, found an initial rise in excretion of glycogenic corticoids in the first trimester of human pregnancy. This later returned to normal values with a falling-off in excretion-rate usually occurring in the last month. Shortly after parturition the values were back to normal levels again.

It was therefore decided to initiate a preliminary study on the ewe to see if any noticeable change in urinary corticoid excretion occurred in this animal during pregnancy and post-partum. This was part of a more extensive study on a possible relationship between adrenal function and birth-weight of the lamb.

Four ewes were observed over the period from conception to lambing and during a few weeks following parturition. Two of the ewes received intramuscular injections of adenocorticotrophic hormone during the last 3 months of pregnancy (dosages of 20 and 40 I.U./day respectively), while the remaining two were untreated.

The chemical method of Norymberski and Stubbs[1] was used for determining urinary excretion of steroids. This method estimates 17-ketogenic steroids. Included in this steroid group is tetrahydrocortisone, a metabolite of hydrocortisone, the main cortical steroid secreted into the blood-stream of sheep[4]. The finding that a marked rise in urinary steroid excretion (rise > 200 per cent) was observed after administration of adenocorticotrophic hormone and a rapid fall occurred when injections of the hormone ceased (fall to 20 per cent) provided physiological justification for the method.

Results showed that, during the greater part of pregnancy, urinary steroid excretion in the sheep did not differ significantly from the seasonal fluctuation of high winter and low summer levels observed in the controls. This seasonal steroid pattern had also been observed previously in man[5]. However, of interest was the marked drop in steroid output which occurred towards the end of pregnancy in all animals studied, treated and untreated with adenocorticotrophic hormone. The urinary output remained still very low immediately following the birth of the lamb, rose during the lactation period and showed a drop when lactation was terminated experimentally. These fluctuations are illustrated in Fig. 1, which is typical of the responses shown by all the animals observed.

A more detailed investigation is being undertaken which will give day-by-day information of steroid excretion-rates over the last month of pregnancy. This should show if the drop in output occurs suddenly or shows a stepwise fall over several days or weeks.

The noticeable fall in steroid excretion just prior to parturition may have one of several explanations: (1) Reduced adrenal cortical activity; (2) altered enzyme activity in the adrenal gland, such as the possible metabolism of progesterone to the steroids concerned with salt and water transfer—corticosterone and aldosterone—rather than its hydroxylation to hydrocortisone; (3) a possible drop in level of circulating progesterone of extra-adrenal origin affecting the amount of adrenal steroid production; (4) reduced stimulus for a possible extra adrenal source of corticosteroids.

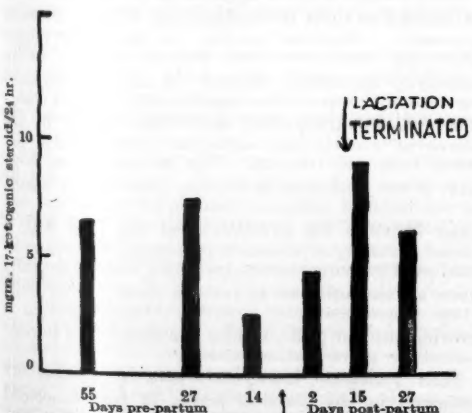

Fig. 1. Urinary 17-ketogenic steroid output in a pregnant ewe before and after parturition. A marked drop in corticoid excretion occurred towards the end of pregnancy, preceding parturition

Further work is required to be done before an adequate explanation can be formulated.

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[1] Norymberski, J. K., and Stubbs, R. D., *Lancet*, i, 1276 (1953).
[2] Schüller, E., *Acta Endocr.*, **35**, 345 (1957).
[3] Venning, E. H., *Endocrinol.*, **39**, 203 (1946).
[4] Bush, I. E., Ciba Foundation Colloquia on Endocrinology, **7**, 210 (J. and A. Churchill, Ltd., London, 1953).
[5] Macfarlane, W. V., and Robinson, K. W., *J. App. Physiol.*, **11**, 199 (1957).

Effect of Dietary Phytate on Fæcal Absorption of Radioactive Ferric Chloride

It has been stated that diets with high phosphate, phytate and low calcium content affect iron absorption by precipitating the iron as an insoluble iron phytate or phosphate; and that this might be a factor in the etiology of the widespread and severe iron-deficient anæmias of the tropics[1–6]. It is known that bulk has a deleterious effect on iron absorption.

Most tropical diets are rich in phosphate and phytates, have a low calcium content and consist largely of bulky carbohydrates. Such diets might be expected to hinder iron absorption.

The approximate milli-equivalents in an 'average' tropical diet of calcium is 20, phosphate 32, phytate 12, iron 0·7 (20 mgm. Fe^{3+}). If combination of iron with phytates and phosphates occurs in the gut it might be expected that on such a diet little iron would remain free; supplementary iron might leave excess of the metal free for absorption. Although the role of calcium in iron absorption is somewhat controversial, calcium in excess might be expected to form calcium phytates and phosphates, and thus reduce the quantity of these compounds available for combination with iron[7–12].

It is likely that all these compounds are mutually reacting and the changes in one will affect the others, and no one of them can be regarded as exclusively concerned in hindering iron absorption or otherwise.

To ascertain the effect of dietary phytates on intestinal iron absorption we have used 6·0–10·0 μc. of oral $^{59}FeCl_3$ with 5 mgm. of carrier in a form of ferrous sulphate with ascorbic acid, and estimated the radioactivity of the stools daily. Absorption of iron was determined by measuring the differences between the activity of the radioiron given and the unabsorbed activity recovered from the fæces; utilization was measured by determining the amount of radioactivity that appeared in the circulating blood as newly synthesized hæmoglobin; this has been found to be the most accurate for determining the iron absorption[13].

The radioactivity of the wet stools was estimated using a ring of six 10-in. matched halogen-quenched Geiger–Müller tubes. The stools were then dried and powdered and the activity re-measured in the Geiger–Müller counter as well as in a scintillation

counter using a 1½-in. thallium-activated sodium iodide crystal.

The subjects, non-anæmic healthy African adults, were given 50 gm. wholemeal bread spread with jam to which was added 3 gm. of 12-sodium phytate; 10–15 ml. water containing the $^{59}FeCl_3$ were then drunk and after this a further 50 gm. of wholemeal bread given. In this way dietary bulk was kept constant. All the stools thereafter were collected daily and analysed separately until they contained less than 1 per cent of the administered radioactivity. One week after this level had been reached, a second similar dose of $^{59}FeCl_3$ was given, but this time with identical amounts of white bread and no phytate. Duplicate tests were then made on the same individuals, reversing the order in which the phytate-fortified diet was given.

Our results indicate that the effect of excess 12-sodium phytate on intestinal iron absorption is varied. In some cases phytate may decrease iron absorption by 20 per cent. For example, an individual given 6 μc. of oral $^{59}FeCl_3$ with 5 mgm. of carrier but no phytate excreted 57 per cent of the administered dose of iron. A second test made on the same individual with the same amount of iron and a similar diet but the latter fortified with 3 gm. of 12-sodium phytate gave an excretion rate of 74 per cent, and a fourth test made without phytate gave an excretion value of 82 per cent (Table 1).

Table 1. Percentage of Iron Excreted

Case No.	No phytate	3 gm. phytate	No phytate
1	57	74	82
2	88	70	68
3	60	58	76
4	72	85	62
5	80	70	85

These iron excretion-rates are lower than those found in normal European and American subjects, and approximate to the excretion values found in anæmic patients in America and Britain. Perhaps this is because the iron stores, as estimated by the iron content of bone marrow, are lower than in Europeans and Americans.

Under the conditions of this experiment and using 12-sodium phytate, there were great variations in the amount of iron absorbed and the effect of phytate on its absorption was not constant.

In man, intestinal iron absorption is not constant, the same individual absorbing different amounts at different times and different individuals have varying absorption-rates. Anæmic individuals generally absorb more iron than non-anæmic, and this is not directly associated with the hæmoglobin values or the extent of their iron stores. Our work, however, was all done on the same non-anæmic individuals, and the different excretion-rates cannot therefore be due to either anæmia, or variations in the extent of their iron stores.

It is unlikely that differences in iron absorption on phytate-fortified diets are due to variations in the hydrolysis of phytic acid to inositol and ortho-phosphoric acid in the gut. Part of the phosphate thus liberated would be available for either absorption or combination with other metals. The extent to which dodeca-sodium phytate undergoes hydrolysis in the gut of man has not yet been worked out but is probably high. It is possible that phytates *per se* have no adverse effect on iron absorption but that the products of its hydrolysis may, in so far as they increase the milli-equivalents of phosphates present in the gut which could combine with available iron and/or calcium. Many animals, particularly the rat, have phytase-producing bacteria in their gut which decompose the phytates before they precipitate iron or calcium; whether this happens in man is unknown. Since dietary bulk was kept constant in all our tests, this is not likely to have entered into the variations in iron absorption.

Whatever part calcium, phosphates and phytates are ultimately found to play in iron absorption and the etiology of tropical iron-deficient anæmias, the work of Hernden and his associates[14] with D-sorbitol makes it evident that the composition of the diet and the intestinal contents play an important part in iron absorption.

Full results of this work will be published elsewhere.

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[1] Macdonald, G., *Ind. J. Med. Res.*, **26**, 1001 (1939).
[2] McCance, R. A., and Widdowson, E. M., *J. Physiol.*, **101**, 44, 304 (1942).
[3] Kinney, T. D., *et al.*, *J. Exp. Med.*, **90**, 137 (1949).
[4] Hegsted, D. M., *et al.*, *J. Nutr.*, **58**, 443 (1956).
[5] Orten, J. A., *et al.*, *J. Nutr.*, **12**, 373 (1936).
[6] Day, H. G., and Stein, H. J., *J. Nutr.*, **16**, 525 (1938).
[7] Kleitson, S. W., *J. Nutr.*, **19**, 187 (1940).
[8] Greig, W. A., *Brit. J. Nutr.*, **6**, 280 (1952).
[9] Chapman, D. G., and Campbell, J. A., *Brit. J. Nutr.*, **11**, 133 (1957).
[10] Sharpe, L. M., *et al.*, *J. Nutr.*, **41**, 433 (1950).
[11] Bronner, F., *et al.*, *J. Nutr.*, **59**, 393 (1956).
[12] Foy, H., and Kondi, A., *J. Trop. Med. and Hyg.*, **60**, 105 (1957). Foy, H., *et al.*, *ibid.* (Feb. 1958). Foy, H., and Kondi, A., *Trans. Roy. Soc. Trop. Med. and Hyg.*, **52**, 46 (1958).
[13] Bothwell, T. H., *et al.*, *J. Lab. Clin. Med.*, **51**, 24 (1958).
[14] Hernden, J. F., *et al.*, *J. Nutr.*, **64**, 615 (1958).

BIOLOGY

Radiosensitivity as a Function of Antigenic Equivocation

Recent studies of factors modifying the response of mammalian tissues to radiation have led to results which cannot be interpreted on existing theories, and a more comprehensive hypothesis on the nature of radiation reactions in multicellular organisms seems necessary. Previous studies on the *C3H* mouse mammary carcinoma had shown that its radiosensitivity apparently depends on an auto-immunizing mechanism or similar manifestation of host resistance, and is consequently determined largely by the degree of genetic and antigenic diversification between host and tumour. This interpretation, however, is not sufficient to explain more recent results on the induced radiosensitization of unmodified isogenic tumours by inoculation of the host with a second, suitably attenuated, inoculum. For example, irradiated isogenic tissues, including tumour isografts given a dose sufficient to prevent their 'taking', will, when inoculated into a mouse already bearing a growing tumour graft, render the established tumour materially more radiosensitive[1].

Since isologous transplants are, by nature, not antigenic in the classical sense, it was concluded that the irradiated inoculum must contain a new or modified antigen capable of influencing a pre-existing balance between the growing tumour and

Table 1. Effect of Various 'Antigens' on the Radiosensitivity of the *C3H* Isologous Tumour treated *in situ* with 4,200 r.

Sensitizing inoculum	No. of mice	Number cured	Cures (per cent)
Uninoculated controls	108	0	0
Irradiated *C3H* tissues, < 5,000 r.	92	26	28
7,000 r.	72	28	39*
10,000 r.	44	8	18
Isografts (unirradiated *C3H* skin)	22	0	0
Hybrid grafts (F_1 and back-cross skin)	44	7	16
Homografts (albino mouse tissues)	74	24	32*
Heterospecific grafts (rat skin)	22	4	18
Heterogeneric proteins (unrelated tissues)	24	0	0

* Note the similarity between homografts and optimally irradiated isografts in their radiosensitizing capacity.

resistance factors in the host. This conclusion has since been confirmed by the demonstration of antigenic changes appearing in irradiated tumours[2] and host tissues[3].

If the radiation-attenuated sensitizing inoculum acts through the formation of a new antigenic constituent, then one would expect that unirradiated homologous tissues from other strains or closely related species, having antigens resembling, but not identical with, those of the tumour, should also have a potent radiosensitizing action. Experiments designed to test this prediction gave positive results (Table 1). Living skin from homologous and related hybrid donors, as well as other homologous tissues and even heterologous skin from a related genus, did in fact succeed in sensitizing the tumour. As in the case of radiation-attenuated isografts, optimal sensitization was obtained when the antigenic constituents of the inocula resembled, but were neither identical with nor too divergent from, the antigens of the tumour and host.

These complex interactions can, it would seem, best be analysed in terms of biological information theory[4]. The effect of irradiation on intracellular structure and function has been ascribed to tautomeric re-arrangement of molecular configuration in the nucleic acids[5], equivalent to the superposition of 'noise' or 'equivocation' upon a specific signal. This would be expected in turn to alter the specific pattern of newly synthesized tissue antigens, including those concerned with homeostatic control of proliferation and growth. Thus radiation-induced equivocation could also affect intercellular regulatory processes.

When a tissue is irradiated *in situ* the degree of equivocation, in effect the noise/signal ratio, apparently becomes sufficient for the autogenous cells to lose their specific identity, and hence become subject to immune processes such as the homograft reaction. The similarities between radiation effects and the phenomena of transplantation immunity have been discussed elsewhere[1]. The inoculation of radiation-attenuated isografts or of genetically incompatible homografts into tumour-bearing animals, both amount to the injection of distorted information into the intercellular feedback system, thus disturbing the existing relatively tolerant host–tumour relationship. This should amplify the effects of local irradiation, and hence account for the induced radiosensitization of tumours.

Since 'information', in the sense used above, is carried by specific material entities, it can be postulated that the 'equivocated substances' generated by irradiation of tissues must be mobile, reaching distant lymphoid tissues in order to evoke the immunological reactions described; diffusible, affecting areas adjacent to the treated site and determining the radiation reaction at these points; and unstable, the local concentration tending to diminish during the post-irradiation period, resulting in a dependence on time in the dose–response relationship. While the first accounts for the experimental results described, the two latter postulates promise to throw some light on the mechanisms underlying the time and volume parameters affecting dosage in clinical radiotherapy.

The 'diffusion' effect has been observed in irradiated human tissue by the increased radiosensitivity of skin adjacent to another treated area, and by the dependence of the intensity of the reaction upon the size and shape of the treated field[6]. Similarly, loss of activated material by decay or reversion to the ground-state amounts to partial 'recovery' from the effects of radiation. The material is likely to be a heterogeneous mixture, and if each product is assumed to decay exponentially the total residual activity, given by the sum of the exponentials, should approximate to a 'power function'[7]. This is in line with the clinical observation that the dose (D) which, when delivered over an extended period (T), is equivalent in effect to a single instantaneous exposure (E), is given to a very close approximation by the power function $D = E \times T^n$, n being a positive fraction[8].

The foregoing 'equivocation' hypothesis could serve to systematize a complex body of data in the field of experimental mammalian radiation biology, and might also furnish a satisfactory explanation for the time and volume factors as they affect the radiosensitivity of human tissues and tumours.

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[1] Cohen, A., and Cohen, L., *Brit. J. Cancer*, **7**, 231, 452 (1953); **8**, 303, 313, 522 (1954); **9**, 600 (1955); **10**, 312 (1956); **11**, 563 (1957).
[2] Maisky, I. N., and Suvorova, G. V., *Bull. Exp. Biol. Med.* (*U.S.S.R.*), **44**, 1121 (1957).
[3] Petrov, P. V., and Ilyina, L. I., *Bull. Exp. Biol. Med.* (*U.S.S.R.*), **44**, 917 (1957).
[4] Quastler, H. (Ed.), "Information Theory in Biology" (Univ. Illinois Press, Urbana, 1953).
[5] Yockey, H. P., *Radiation Res.*, **5**, 146 (1956).
[6] Jolles, B., *Brit. J. Radiol.*, **23**, 18 (1950).
[7] Norris, W. P., Tyler, S. A., and Brues, A. M., *Science*, **128**, 456 (1958).
[8] Cohen, L., and Kerrich, J. E., *Brit. J. Cancer*, **5**, 180 (1951).

Demonstration of Endogenous Pyrogen in Serum during Systemic Tuberculin Reaction in Rabbits

Substances capable of producing fever in normal recipients (the so-called endogenous pyrogens) appear in the serum of experimental animals during fever due to bacterial endotoxin, influenza virus and streptococcal and pneumococcal infections[1]. Systemic tuberculin reaction is very similar to the effect of bacterial endotoxins[2]. An attempt has therefore been made to demonstrate the presence of substances with an effect corresponding to that of endogenous pyrogen in the serum of experimental rabbits during systemic tuberculin reaction.

Induction of hypersensitivity in rabbits with B.C.G. infection, signs of systemic tuberculin reaction and passive transfer of hypersensitivity with white blood cells and spleen cells have been described elsewhere[2]. Blood was collected under sterile conditions by cardiac puncture approximately 2 hr. after intravenous administration of purified tuberculin (0·005 mgm. PPD). It was allowed to clot, kept overnight in an ice-box, the serum was drawn off, centrifuged at 2,000 r.p.m. for half an hour and kept at − 20° C. All glass used, syringes and needles were washed thoroughly in water free of pyrogen before sterilization and all sera were tested for sterility. Rabbits were rendered tolerant to endotoxin by 10 daily injections of 10^8 heat-treated *Salmonella paratyphi B*. Tolerance was tested daily by taking body-temperatures after injection of *S. paratyphi*; the sera were tested on the first day after the last injection of the vaccine. Sera were injected intravenously in doses of 10–25 ml. Body-temperatures were recorded with a rectal thermometer twice within the ½ hr. preceding the experiment and then ¼, ½, 1, 2, 3 and 4 hr. after injecting the serum. Rabbits having a temperature higher than 39·5° C. or showing a difference of more than 0·2 deg. C. between the measurements before the experiment were not used.

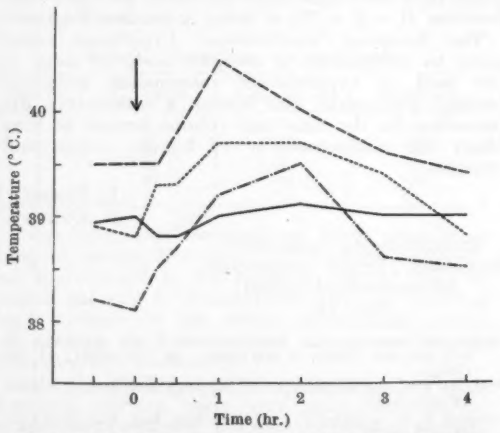

Fig. 1. Rectal temperature changes in rabbits after intravenous administration (arrow) of 20 ml. of sera obtained from: ———, normal rabbit; ·····, actively sensitized rabbit injected with 5 μgm. of PPD; —·—·—, actively sensitized rabbit injected with 5 μgm. of PPD, serum being given to endotoxin-tolerant recipient; – – – –, rabbit passively sensitized with hypersensitive cells, injected with 5 μgm. of PPD

Fig. 1 shows a typical effect of normal serum and serum collected during systemic tuberculin reaction. In all positive cases the result was similar: a short monophasic fever without a latent period. With control sera the increase in temperature was usually not more than 0·2 deg. C.; sometimes the temperature decreased. The difference in temperature produced 1 hr. after injection of serum was taken as the criterion for evaluation of the experiments (Table 1). It is evident that the large majority of control sera gives negative results. The sera collected during the systemic tuberculin reaction in rabbits that had been rendered hypersensitive, actively or passively, gave mostly positive results. These results cannot be ascribed to the effect of non-specific endotoxic substances which are known to be present in non-purified tuberculin[4].

Table 1. Appearance of Fever in Rabbits Injected Intravenously with Febrile and Non-febrile Sera

The number of negative, moderately positive and positive results is shown. + indicates fever induced; − indicates absence of fever

Characteristics of the sera used			Rise in body temperature in recipients (deg. C.)		
Experimental groups of rabbits	Injected with	Fever response	0–0·3	0·5–0·7	0·8–1·3
BCG sensitized	PPD	+	11	8	9
	PPD	+*	—	1	4
	—	—	10	—	—
Controls	PPD	—	15	1	—
	—	—	14	1	—
Passively sensitized with cells	PPD	+	4	6	3
	—	—	4	—	—
Acceptors of normal cells	PPD	—	6	—	—

* Given to recipients tolerant toward endotoxin.

The fundamental characteristics of an endogenous pyrogen are the ability to induce a short immediate fever and the preservation of this ability on transfer to rabbits tolerant toward endotoxin[1]. Both these points have been demonstrated in present experiments. The results in Table 1 show that an endogenous pyrogen is produced by a reaction between a small amount of purified tuberculin and cells of hypersensitive rabbits, both in actively sensitized rabbits and after transfer of hypersensitive cells into normal recipients.

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[1] Wood, W. B., *Lancet*, ii, 53 (1958).
[2] Stetson, Ch. A., *J. Exp. Med.*, **101**, 421 (1955).
[3] Johanovský, J., *Folia microbiologica*, **4**, 101 (1959).
[4] Stetson, Ch. A., *Fed. Proc.*, **17**, 536 (1958).

Virus-like Particles in chemically induced Carcinoma of the Uterine Cervix

The ultra-microscope structure of carcinoma cells has been thoroughly studied, but essential differences between neoplastic and normal cells have so far not been established, with the possible exception of so-called 'virus-like particles'[1].

Virus-like particles are reported to occur in mammary carcinoma of mice known to carry the milk factor[2–4] and several groups of investigators interpret these particles as the materialization of the mammary tumour virus. Pitelka *et al.*[5] demonstrated the presence of identical virus-like particles in hyperplastic alveolar nodules of the mammary gland of the *C3H/He CGRL* mouse, a lesion generally considered as a precursor of mammary carcinoma. Howatson and McCulloch[6] described virus-like particles in a transplantable mouse plasma cell tumour which originated in a female *C3H/He* mouse. To the best of our knowledge, these characteristic particles have not been found in chemically induced tumours.

Our material consists of virgin *C3H/A* mice, a number of which has been treated with bi-weekly applications of 3,4-benzopyrene. Invasive cervical carcinoma occurred after forty weeks. Ultra-thin sections of these tumours were examined in the electron microscope. The ultra-morphology of the tumours has been described elsewhere[7]. In a certain number of slides, we found intra- and extra-cellular

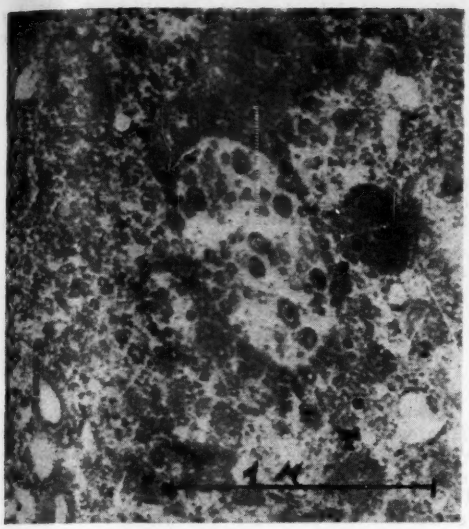

Fig. 1. Virus-like particles gathered into an elliptical cluster in the cytoplasm of a chemically induced cancer cell of the uterine cervix of a mouse

particles morphologically indistinguishable from the virus-like particles described in mammary tumours (Fig. 1).

The particles are almost circular in shape with an external diameter of 500–800 A. The centre is often found empty, but sometimes contains a dense core, 300–400 A. in diameter, surrounded by one or two concentric membranes separated by an interspace of lesser optical density. The number of particles per cell section varies. The corpuscles are scattered through the cytoplasm or gathered into irregular elliptical or circular clusters. Particles may be seen surrounding intra-cytoplasmic vacuoles. Tumour cells heavily laden with particles were often found in the immediate vicinity of others containing no particles whatsoever. The intercellular spaces, large and irregular, often showing deep infoldings of the plasma membranes, may harbour large numbers of virus-like particles. Irregularly shaped inclusions of dense homogeneous material are encountered within the cytoplasm of several neoplastic cells. Scattered throughout the matrix of these amorphous inclusion bodies, varying numbers of characteristically shaped particles may be found.

Virus-like particles have not been discovered in liver, spleen, intestine, colon, breast or pancreas of treated mice.

The presence of virus-like particles in a chemically induced carcinoma of the cervix is puzzling, even though *C3H/A* mice are known to have the milk factor and to be disposed to mammary carcinoma.

For several reasons, it needs a stretch of the imagination to admit that the chemically induced uterus cancer of mice would be caused by a virus. As a matter of fact, in contradistinction with the breast cancer, carcinoma of the cervix scarcely ever occurs spontaneously in mice. Furthermore, polycyclic hydrocarbons can induce tumours in almost any organ of this animal.

We cannot prove, of course, that the particles described are not simply due to casual viral infection, though we do not understand why contamination should remain confined to the cervix. Should casual infection be proved, it still would not have any bearing on the induction of a (necessarily pre-existing) tumour. A hypothesis demanding further investigation is whether these virus-like particles should not be considered as a morphological substratum of the neoplastic reaction, an assumption which applies as well to spontaneous as to experimentally induced tumours. In other words, we wonder whether virus-like particles may not happen to be a result, rather than the cause, of the carcinomatous process.

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[1] Dalton, A. J., and Felix, M. D., *Ann. N.Y. Acad. Sci.*, **63**, 1117 (1956).
[2] Dmochowski, L., *Acta Internat. contra cancrum*, **12**, 582 (1956).
[3] Bernhard, W., Guérin, M., and Oberling, C., *Acta Internat. contra cancrum*, **13**, 544 (1956).
[4] Bernhard, W., *Cancer Res.*, **18**, 491 (1958).
[5] Pitelka, D. R., Bern, H. A., DeOme, K. B., Schooley, C. N., and Wellings, S. R., *J. Nat. Cancer Inst.*, **20**, 3, 541 (1958).
[6] Howatson, A. F., and McCulloch, E. A., *Nature*, **181**, 1213 (1958).
[7] De Rom, F., Thiery, M., Sebruyns, M., De Groodt, M., and Lagasse, A., Festschrift Prof. Koller (in the press).

Histochemical Demonstration of A and B Antigens in Platelets

The existence of A, B, AB and O groups in platelets has been shown by Gurewitch and Nelken[1], and confirmed by other authors. This communication deals with the application of fluorescent antibody technique[2] for the investigation of platelet antigens.

Blood samples from A, B, AB and O donors were obtained in 'Complexon III'. The platelets were separated by differential centrifugation and washed twice in phosphate-buffered saline *p*H 7·0. Rabbit and chicken[3] anti-human globulin sera were used for conjugation with fluorescein *iso*thiocyanate (kindly provided by Difco). The conjugation procedure was as follows: to 6 ml. of anti-human globulin serum the following solution was added: saline 6·25 ml.; buffer CO_3-HCO_3 0·5 *M*, *p*H 9·0, 2 ml.; and acetone 1·25 ml. Fluorescein *iso*thiocyanate (25 mgm.) was added directly to the reaction mixture with stirring and stored for 18 hr. in an ice-box. The unconjugated fluorescein was removed by dialysis at 4° C. against 0·15 *M* sodium chloride, 0·01 *M* phosphate buffer *p*H 7·0, for a period of 5–6 days. The third conjugate used in the experiments was a sheep anti-rabbit globulin fluorescein conjugate (a commercial preparation of Sylvana Chemical Co.). All conjugates were heated at 56° C. for 20 min., thoroughly absorbed with washed thrombocytes and red cells and checked for the presence of specific antibodies prior to use. The absorption is a very important step of procedure, since platelets may non-specifically bind the stained protein molecules from unabsorbed conjugates.

Two staining procedures were performed. First, two drops of A, B or AB platelets suspension (approximately 8,000,000 cells per ml.) were mixed with

corresponding anti-serum (anti-A, anti-B, or anti-A,B) and left for 2 hr. at 20° C. The cells were then washed three times in buffered saline and to one drop of suspension four drops of chicken (or rabbit) anti-human globulin conjugate were added. The incubation lasted for 90 min. at room temperature followed with one washing of platelets. Finally, the cells were resuspended in glycerol containing 10 per cent buffered saline, and one small drop of suspension was transferred on to a slide and flattened with cover slip. Each suspension was checked for number and conditions of cells with a phase-contrast microscope. Controls for first staining procedure were : (*a*) platelets plus conjugate ; (*b*) platelets from group A plus anti-B serum plus conjugate, and cells from group B plus anti-A serum plus conjugate. The second staining procedure was similar to that already described for leucocytes[4] : (*a*) platelets were exposed to anti-serum as above ; (*b*) the cells were washed and treated with rabbit anti-human globulin serum at 37° C. for 2 hr. (serum absorbed with thrombocytes and red cells was used) ; and (*c*) washed platelets were brought into contact with the sheep anti-rabbit globulin conjugate and incubated for 90 min. at room temperature. Controls for the second procedure were as follows : (*a*) platelets plus conjugate ; (*b*) platelets from group A plus anti-B serum plus conjugate, and cells of group B plus anti-A plus conjugate ; (*c*) cells plus anti-human globulin serum plus conjugate (anti-serum was omitted) ; and (*d*) platelets plus anti-serum plus conjugate (anti-human globulin serum was omitted). A Reichert fluorescent microscope equipped with dark-field condenser and an Osram *HBO* 200 mercury lamp was used. The microphotographs were taken on Agfa 'Fluorapid' film.

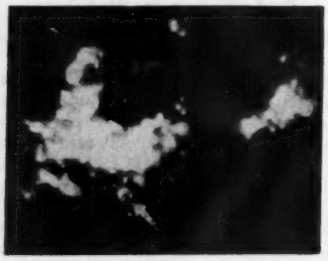

Fig. 1

The results have shown that the positive staining is only obtained when A, B or AB platelets were treated with anti-A, anti-B or anti-AB serum respectively. Thrombocytes from group O exposed to anti-A, anti-B or anti-AB serum did not show the fluorescence. The same holds for all controls. Fig. 1 (× 500) shows brightly stained clumps of platelets from group A treated with anti-A and chicken anti-human globulin conjugate (the arrow shows a stained erythrocyte). Both staining procedures were proved to be useful in demonstrating A and B antigens in thrombocytes. It should be pointed out that the method described here is performed on the cell suspension and includes specific adsorption of all reagents. No fixatives were used. Since we have succeeded in staining leucocytes[4] and red cells[5] specifically using fluorescein-labelled antibodies, it seems that fluorescent antibody technique may be successfully applied in the field of immuno-hæmatology.

We are indebted to the Institute for Nuclear Sciences, Vinča, for making a fluorescent microscope available for this study.

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[1] Gurevitch, J., and Nelken, D., *Nature*, **173**, 356 (1954).
[2] Coons, A. H., and Kaplan, M. H., *J. Exp. Med.*, **91**, 1 (1950).
[3] Janković, B. D., Simonović, B., and Lincoln, T. L., *Vox Sang.*, **3**, 304 (1958).
[4] Janković, B. D., and Lincoln, T. L., *Experientia* (in the press).
[5] Janković, B. D., *Exp. Cell Res.* (in the press).

T2 Phage Infection of 'Protoplasts' obtained by Penicillin Treatment of *Escherichia coli B*

It was observed by Lederberg[1] that cells of *E. coli B*, grown in the presence of penicillin, changed in hypertonic solutions to spherical corpuscles that were readily lysed when transferred to a hypotonic medium. These corpuscles exhibited osmotic characteristics similar to those of various bacterial protoplasts. We have studied the adaptive activity to synthesize β-galactosidase of *E. coli B* 'protoplasts' obtained by penicillin treatment, according to Lederberg's method. We found that the addition of *T2* phage immediately stops β-galactosidase synthesis, as it does in *E. coli B* cells[2]. The present communication deals with the mechanism of this process.

For the preparation of 'protoplasts' 90 ml. of a culture of *E. coli B*, grown overnight at 37° C. in a nutrient broth similar to 'Difco Penassay', was added to 210 ml. of the same medium containing 20 per cent sucrose, 0·20 per cent magnesium sulphate and 1,000 units/ml. of penicillin. The mixture was shaken for 3 hr. at room temperature. As revealed by phase-contrast microscopy, the above treatment changed 95 per cent of the cells to round corpuscles. The 'protoplasts' thus obtained were centrifuged and resuspended at 1×10^9/ml. in broth containing 0·6 *M* sucrose and 2 per cent serum albumin, and infected with *T2* phage at 6×10^8/ml. After 5 min. the sample was diluted to 1 : 100 and was shaken at 30° C. in a water-bath. The hundredfold dilution of the samples is very important, not only for inhibiting the re-adsorption of the resulting phage particles, but also because the lysed 'protoplasts' inactivate the free *T2* particles very quickly. *E coli B* cells, serving as controls, were treated in the same way except for the addition of penicillin. For the determination of phage particles during their multiplication cycle we used the premature lysis method of De Mars[3].

As shown in Fig. 1, under these experimental conditions the *T2* phage can infect the cells as well as the 'protoplasts' derived from them, and both can synthesize the virus at nearly the same rate. No phage synthesis was observable when the 'protoplasts' were incubated for 10 min. in a hypotonic solution (0·9 per cent sodium chloride) before infection, because of the resulting osmotic lysis.

As in normal bacterial cells the receptors for *T2* phage are known to be present in the cell wall, the above findings suggest that the treatment with penicillin does not cause general damage to this structure. If it is assumed that the *T2* phage receptors are bound exclusively to the lipoprotein component of the cell wall[4], the phenomenon observed can readily

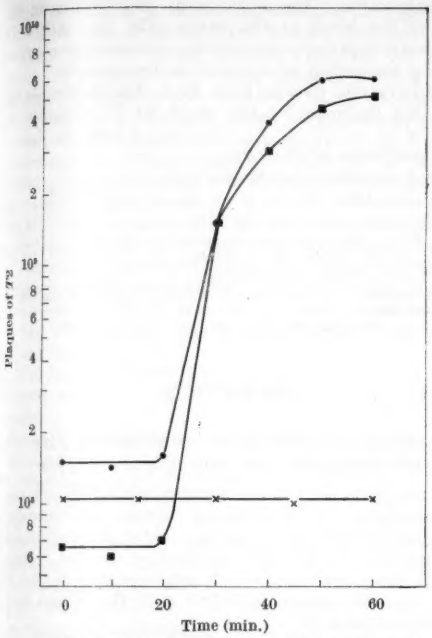

Fig. 1. Multiplication of *T*2 phage. ●—●, In *E. coli B* cells; ■—■, in 'protoplasts'; ×—×, in lysed 'protoplasts'

be explained, as penicillin is supposed to inhibit only the synthesis of the mucocomplex component[5–7] responsible for the rigidity and the actual morphology of the cell wall[8].

We are inclined to think, on the basis of our observations, that certain cell preparations of McQuillen[9] may also have had more or less cell-wall components on their surface.

When accepting the proposed definition for protoplasts[10], the spherical particles obtained from *E. coli B* by penicillin treatment can scarcely be considered as typical, since they are sensitive to *T*2 phage infection, that is, they seem to have the appropriate receptors undamaged on their surfaces.

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[1] Lederberg, J., *Proc. U.S. Nat. Acad. Sci.*, **42**, 574 (1956).
[2] Monod, J., and Wollmann, E., *Ann. Inst. Pasteur*, **73**, 937 (1947).
[3] De Mars, R. I., *Virology*, **1**, 83 (1955).
[4] Weidel, W., Koch, G., and Lohss, F., *Z. Naturforsch.*, **9b**, 398 (1954).
[5] Park, J. T., and Strominger, J. L., *Science*, **125**, 99 (1957).
[6] Lederberg, J., *J. Bact.*, **73**, 144 (1957).
[7] Salton, M. R. J., and Shafa, F., *Nature*, **181**, 1321 (1958).
[8] Work, E., *Nature*, **179**, 841 (1957).
[9] McQuillen, K., *Biochim. Biophys. Acta*, **27**, 410 (1958).
[10] Brenner, S., *et al.*, *Nature*, **181**, 1713 (1958).

The Inferior Mesenteric Ganglion in Man

The inferior mesenteric ganglion has been studied in the cat by A. J. Harris[1] and in the rabbit by G. Brown and J. E. Pascoe[2]; but in man, however, no full description of the anatomy of the ganglion itself has yet appeared.

A series of 19 stillbirths and neonatal infants, ranging from 7½ months to full term, were dissected after having been injected with embalming fluid through the umbilical vein.

The inferior mesenteric plexus was easily found by tracing down the intermesenteric nerves to their junction with it. The plexus was then dissected very carefully under a powerful lens, the nerves being teased away with a fine dissecting needle until a solid white structure, the inferior mesenteric ganglion, was isolated. In each specimen one or two ganglia were found, variable in size, and although some were small they all could easily be seen with the naked eye. They were in close proximity to the inferior mesenteric artery, being placed on either its left or right side. In three specimens two separate ganglia were found receiving nerves from their respective sides. Branches from the left ganglion tend to run to the distal part of the transverse colon, descending colon and upper part of the pelvic colon; while those from the right one accompanied the parent artery into the pelvic mesocolon to innervate the lower part of the sigmoid colon and upper part of the rectum.

The inferior mesenteric ganglion is a well-defined body capable of isolation and may be said to be a constant structure in man. It is an important relay station in the nerves to the distal part of the large intestine.

Further details of this work will be presented for publication at a later date.

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[1] Harris, A. J., *J. Comp. Neurol.*, **79**, 1 (1943).
[2] Brown, G., and Pascoe, J. E., *J. Physiol.*, **118**, 113 (1952).

A New Leech-infesting Cercaria from Duddingston Loch, Edinburgh

Valvata piscinalis, a common snail in the Duddingston Loch, Edinburgh, was found infected with a new furcocercous cercaria. Of 758 snails examined, 19 were found infected. This cercaria, which is named *Cercaria valvatae* n.sp., develops in long tubular sporocysts forming a tangled mass in the hepatopancreas of the snail. With the proliferation of the germ balls the tubular sporocyst becomes constricted into sausage-shaped swellings containing developing cercariae. The abbreviated specific diagnosis of *Cercaria valvatae* n.sp. (Fig. 1) is as follows.

Body, oval without eye-spots, 0·18–0·22 mm. long and 0·084 mm.–0·1 mm. broad. Anterior end beset with transverse rows of minute spines. Oral organ protrusible, 0·036 mm. × 0·025 mm. to 0·045 mm. × 0·03 mm.; divisible into two parts, anterior part thin, posterior part muscular. Ventral sucker equatorial or post-equatorial, highly muscular, protrusible, 0·027 mm. × 0·025 mm. to 0·03 mm. × 0·028 mm. Prepharynx small, pharynx globular, 0·014 mm. diameter, œsophagus 0·03 mm. long. Intestinal cæca extend slightly posterior to the ventral sucker. Penetration glands 3 pairs, bilobed, granular, posterior to ventral sucker, opening by long ducts at the base of oral organ. Excretory bladder, ovoid; flame cells six pairs, five in the body and one in the tail stem. Tail stem 0·16–0·23 mm. long. Caudal furci 0·19 mm.–0·21 mm. long, not provided with fin or membrane.

Of the furcocercous cercariae described from Great Britain this cercaria comes nearest to *Cercaria F*[1], *Cercaria Y*[3], *Cercaria micromorpha*[3] and *Cercaria pygocytophora*[4], but differs from these in the number of either the penetration glands or the flame cells.

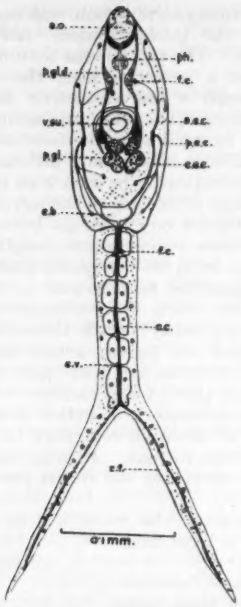

Fig. 1. *Cercaria valvatae* n.sp. showing morphological details

It is also distinct, besides other features, in the nature and number of penetration glands or flame cells from *Cercaria cristata* and *Cercaria longiremis* described from *Valvata piscinalis* from the Continent by Wesenberglund[5] as also from the cercariae of *Aptemon gracilis* and *Cotylurus cornutus* producing tetracotyle larvæ in leeches described by Szidat[6] and the American *Cercaria burti*.

A large number of infection experiments were tried with a variety of animals to find out the intermediate host of *Cercaria valvatae* n.sp. This revealed the quick penetration of this cercaria within 2–3 min. into the body of the leech *Helobdella stagnalis*, followed by casting of the furcocercous tail and entry into its hæmo-cœlomic system. In the next 3–4 days the cercarial structures were lost and in 7–8 days new structures developed and a cyst was secreted around the tetracotyle. The cysts were clearly seen in the body of the leech at this stage (Fig. 2). About 28 days were required between the cercarial penetration and the formation of a complete tetracotyle.

Fig. 2. Cysts of tetracotyle in the body of the leech

I am grateful to (the late) Prof. James Ritchie for providing facilities for this work at Edinburgh.

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[1] Harper, W. F., *Parasit.*, **23**, 310 (1931).
[2] Rees, F. G., *Proc. Zool. Soc.*, 1 (1932).
[3] Brown, F. J., *Parasit.*, **18**, 21 (1926).
[4] Brown, F. J., *Parasit.*, **23**, 88 (1931).
[5] Wesenberglund, C., *Mem. de L'Aced. Roy. des Sci. et des Lett. de Danemark*, 1 (1934).
[6] Szidat, L., *Zool. Anz.*, **86**, 133 (1929).

GENETICS

Linkage of Polygenes controlling Size of Ascospore in *Neurospora crassa*

It has been shown in earlier work[1,2] that the size of ascospore in *Neurospora crassa* is controlled by a polygenic system. In the course of experiments designed to give further information on this system, results were obtained which indicate that a part of the polygenic system is linked with the albino locus on chromosome I.

The strains used were 232·1, 232·2, 232·3 and 232·4, all of which are albino (*al*-2), large-spored strains comprising a 4-spored ascus obtained from the sixteenth generation of selection for increased ascospore size[3].

These strains were crossed to the appropriate wild type and the crosses incubated at 25° C. 50 ascospores were randomly isolated from each cross. The F_1 ascospores were normal in size. The isolates thus obtained were each back-crossed to the large-spored parent. This gave a total of 29 crosses in which albino F_1 strains were back-crossed and 48 crosses in which non-albino F_1 strains were back-crossed. A sample of 50 ascospores from each cross was measured. The results are presented in Table 1.

The majority of back-crosses involving albino F_1 strains had mean ascospore-lengths in the range 19·42–22·30, while the majority of back-crosses involving non-albino F_1 strains had mean ascospore lengths in the range 17·26–18·92. The difference, 1·02 units, between the mean ascospore-length of the two groups of back-crosses is highly significant ($P < 0·001$ per cent), which indicates that some of the genotypic material controlling size of ascospore segregated in association with the albino locus. That is, there is linkage between this genotypic material and the albino locus. This genotypic material is responsible for approximately one-sixth of the total

Table 1. Back-crosses of *al* and *al*$^+$ F_1 Strains to Large-spored Parents

	al F_1 strains	*al*$^+$ F_1 strains
No. of back-crosses with mean in range 17·26–18·92	2	43
No. of back-crosses with mean in range 19·42–22·30	25	5
No. of intermediates	2	0
Total No. of back-crosses	29	48
Mean ascospore length*	19·84	18·82
Standard deviation of mean	0·019	0·033

For difference between means, $t = 13·077$; $P < 0·001$ per cent.
* 1 unit = 1·72μ.

response (about 6 units) to selection for increased ascospore size obtained over sixteen generations[2].

From Table 1 it can be seen that two out of the 29 *al* F_1 strains, when back-crossed, gave a mean ascospore-length in the 17·26–18·92 range, and five of the 48 *al*+ F_1 strains, when back-crossed, gave a mean ascospore-length in the range 19·42–22·30. It is reasonable to regard these exceptions as due to crossing-over occurring between the albino locus and the site of the genotypic material controlling this part of the response to selection for increased ascospore size. If this is so, then this genotypic material is located about 9 cM. from the albino locus, calculated on the assumption of seven recombinations in a total of 75 back-crosses. As yet it is not possible to say whether this site is proximal or distal to the albino locus.

The length of ascospore of the majority of back-crosses fell into one or the other of two distinct classes. There were, however, two *al* F_1 strains where the mean ascospore length of the back-cross was intermediate between the two classes. The mean ascospore-lengths of these two back-crosses were 19·18 and 19·26. These intermediate cases were probably due to the segregation of the genotypic material controlling the rest of the response to selection for increased ascospore size. These two intermediate cases have not been included in the approximate estimation of the degree of linkage of the genotypic material to the albino locus.

Further work is being carried out in order to establish more precisely the position of this part of the genotypic material controlling ascospore size. This work will be reported in more detail elsewhere.

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[1] Pateman, J. A., *Nature*, **176**, 1274 (1955).
[2] Pateman, J. A., *Heredity* (in the press).

Ratio of Visible to Lethal Mutations produced in *Drosophila* by Phenylalanine Mustard

The present experiments were undertaken in order to see whether we could confirm the high visible mutation-rate relative to the lethal mutation-rate induced in *Drosophila* by phenylalanine mustard as compared with X-irradiation, reported by O. G. and M. J. Fahmy[1]. Since this high visible rate would imply (1) the existence of loci specifically concerned with visible mutations and as a group qualitatively different from non-visible loci and (2) a specific effect of the agent on such loci, it seemed important that this work be repeated.

Wild-type males of *Drosophila melanogaster*, 12–30 hr. old, were injected intra-abdominally with approximately 0·001 ml. of a 10^{-2} *M* suspension of *p*-N-di(chloroethyl)amino - phenylalanine(phenylalanine mustard) in distilled water or in 0·75 per cent saline, the amount injected being sufficient to cause noticeable swelling of the abdomens. The survivors were tested for sex-linked recessive lethal and visible mutations by the Muller-5 technique. An average of 9–10 daughters from each treated or control male was tested for mutations, several of the sons of each female being carefully scrutinized for visible mutations. In some experiments all the sons of each female were examined for visible mutations with the expectation of detecting delayed mutants and also mutants of such weak expression that not all the F_2 red-eyed sons would show the mutant trait. Table 1 shows the results of these tests, as well as results from control males into which distilled water or 0·75 per cent saline only was injected (distilled water versus saline having been found to have no significant influence on the rate of mutation).

Although the mutagenic effectiveness of phenylalanine mustard in our experiments is shown by the lethal-rate in Table 1, no visible mutations were found. This fact is difficult to reconcile with the report of the Fahmys[1] that from phenylalanine mustard-treated males 381 recessive visible mutations were found among 25,622 'treated *X*-chromosomes' in a series giving 7 per cent of lethals. After allowance is made for the lower lethal mutation-rate in our experiments, we should have recovered at least 6 visible mutants if we had found visible mutations in as high a proportion to lethals as the Fahmys did, a number that differs significantly from the number (0) found by us. However, this number does not differ significantly from the 2 or 3 visibles that would have been expected if X-rays had been used as the mutagenic agent, since the ratio of visible to lethal mutations found previously by various workers using the same type of genetic technique is in the range of 1 : 7 to 1 : 10. The report of the Fahmys[1] that phenylalanine mustard produces a ratio of visible to lethal mutations of nearly 3 : 10 (279 visibles in a population containing 999 lethals) is not confirmed by our work, since our finding of no visibles does differ significantly from an expectation of finding 2 : 7 ($P = 0·05$) or 2 : 10 ($P = 0·02$). Thus the chemical used could not be as much as twice as effective as X-rays in producing visibles as compared with lethals.

In explanation of the discrepancy between our results and those of the Fahmys, it should be mentioned that the Fahmys used a method of detecting visible mutations different from that used by us and by X-ray workers in general, in that they looked particularly for their visibles in suspected lethal or semi-lethal cultures, examining these cultures until the very end of their hatching period (though this

Table 1

Agent	No. of males treated		No. of chromosomes tested (no. of lethals in parenthesis)		Mutation-rate	
	Brood 1 (0–6 days)	*Brood 2* (7–12 days)	*Brood 1* (0–6 days)	*Brood 2* (7–12 days)	Lethal	Visible
Phenylalanine mustard	121	65	1,056 (15)*	742 (12)*	1·5 ± 0·3%	0
Distilled water or 0·75 per cent saline	113	90	1,048 (3)†	831 (1)	0·2 ± 0·1%	0

* Two lethals were obtained from each of three treated males and have been considered as being of common origin in calculating the error of the mutation-rate, in accordance with Muller's method of statistical treatment (ref. 2).
† One semi-lethal.

procedure is only mentioned in passing on one of their earlier publications[2] and came to our attention after the completion of the present experiments). As is well known, the few surviving males in semi-lethal cultures are often abnormal. The Fahmys's 'visible' rate, relative to complete lethals, would therefore be very high, since most workers would include semi-lethals of very low viability with the complete lethals rather than with visibles. Moreover, the exclusion of the semi-lethals from the lethal class would further increase the visible rate relative to the lethal rate.

In conclusion, it might be pointed out that a lethal is often a visible of very low viability and that the distinction between 'lethals' and 'visibles' is really a matter of convenience. On general grounds, therefore, it is scarcely to be expected that any mutagenic agent should specifically produce visible effects, as contrasted to lethal.

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[2] Fahmy, O. G., and Fahmy, M. J., *J. Genet.*, **54**, 146 (1956).
[3] Muller, H. J., *Genetics*, **37**, 608 (1952).
[4] Fahmy, O. G., and Fahmy, M. J., *Drosophila* Information Service, **27**, 88 (1953).

A Position-Effect Explanation of Gene Conversion

Gene conversion was the name given by Winkler[1] to the transformation in a heterozygote of a + allele into a mutant allele, or of one mutant into another. He intended to explain recombination and crossing-over through digenic conversion of allele *A* into *a* in one chromosome and simultaneously of *a* into *A* in its homologue. Monogenic conversion, in only one chromosome, should also be possible, but this would not easily be distinguished from mutation. More recently, conversion has been used only in the monogenic sense[2] in which it is demonstrated chiefly through tetrad analysis from heterozygotes *Aa* when the expected Mendelian segregation of $2A : 2a$ is not obtained.

However, tetrads with three mutants and 1 + spores may be produced also from intragenic cross-over, that is, cross-over which takes place within a gross locus subdivided into sub-loci corresponding to sub-alleles or pseudo-alleles[3]. Typical intragenic cross-over has been demonstrated, for example, in the adenine-3 gross locus of *Neurospora*[4]. In a gene *b* subdivided into sub-alleles b_1 and b_2, the cross of a b_1 by a b_2 strain may be represented as $b_1 + \times + b_2$, and this will give a tetrad $b_1 +$, $+ +$, $b_1 b_2$, $+ b_2$. If no distinction is made between the phenotypes of b_1 and b_2, the apparent result is *b*, +, *b*, *b*, or three mutants to 1 +. This is apparent conversion, which may be separated from true conversion only when sub-alleles are distinguishable.

Variegated conversion—the production of variegation in a heterozygote, not attributable to any apparent chromosome aberrations—has been reported to occur in *Oenothera*[5], but further analysis will be necessary before it can be generally admitted. True conversion, not associated with variegation, may be called stable conversion or transmutation[6]. This is at present the most important form of conversion since it has been plainly demonstrated to occur in *Neurospora*[7,8], and very probably in *Saccharomyces*[9,10] and some other species. Its importance stems from the fact that it constitutes a proved exception to Mendelian theory.

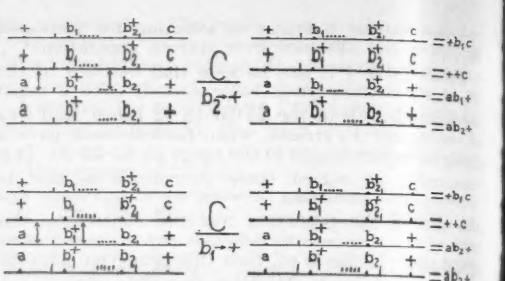

Fig. 1. Conversion of b_2 into + and of b_1 into +, corresponding respectively to asci 1 and 4 of Mitchell (ref. 7). Conversion results from relocation, by cross-over, of sub-alleles b_1 or b_2 adjacently to a different intermediary segment between them, which caused position effect (dotted) now reverting to +

Two types of explanations have been advanced for true, stable conversion: namely, a differential and compensatory reduplication, for example, the + allele reduplicating twice while allele *a* does not reduplicate[7]; and a transfer of chemical groups from one allele to the other, so as to result in a kind of mutation. The transfer might also be effected as a dislocation of groups similar to a kind of Thompson's *episomes*[10], or through enzymes and during gene reduplication[8], or by means of a transductor[11], reminiscent of transduction phenomena in bacteria. These are *ad hoc* hypotheses which lead neither to generalization nor to the possibility of prediction. An explanation is offered here, based on mechanisms known to operate at other levels, and which it is only necessary to extend to the intragenic level. Stable conversion is explained by intragenic cross-over which, by separating sub-loci, restores the intragenic position effect that caused the mutant phenotype. Fig. 1 shows how the explanation works for two of the asci in the clearly demonstrated case of *Neurospora*[7]. For simplicity of lettering, the loci studied by M. B. Mitchell[7] will be designated *a* for pyrimidine-1, b_1 for pyridoxine *p*H-sensitive, b_2 for pyridoxine non-*p*H sensitive, *c* for colonial. Other markers, located far from the *b* gross locus, are not necessary for this explanation. b_1 and b_2 are sub-alleles. Between them will be a segment of the *b* gross locus which causes position effect (see also legend of Fig. 1). Other conversion-asci are similarly explained. The explanation implies negative interference[9].

Details of this work will be published elsewhere.

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[1] Winkler, H., "Die Konversion der Gene" (Gustav Fischer, Jena, 1930).
[2] Lindegren, C. C., *J. Genet.*, **51**, 625 (1953).
[3] Serra, J. A., *Portug. Acta Biol.*, A, **5**, 100, 134, 141 (1958).
[4] Giles, N., DeSerres, F., and Barbour, E., *Genetics*, **42**, 608 (1957).
[5] Renner, O., *Planta*, **48**, 342 (1957). Goldschmidt, R., *Amer. Nat.*, **152**, 93 (1958).
[6] Horowitz, H. N., cf. Beadle, G. W., Symp. on "Chemical Basis of Heredity", 3 (Johns Hopkins Press, Baltimore, 1957).
[7] Mitchell, M. B., *Proc. U.S. Nat. Acad. Sci.*, **41**, 215, 935 (1955).
[8] Mitchell, H. K., Symp. on "Chemical Basis of Heredity", 94 (Johns Hopkins Press, Baltimore, 1957).
[9] Roman, H., *Cold Spring Harbor Symp. Quant. Biol.*, **21**, 175 (1956).
[10] Winge, Ø., *Heredity*, **9**, 573 (1955).
[11] Goldschmidt, R., *Proc. U.S. Nat. Acad. Sci.*, **43**, 1019 (1957).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 9

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Sir Charles Darwin, F.R.S.: "Darwin the Traveller".

Tuesday, March 10

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at 14 Belgrave Square, London, S.W.1), at 10.30 a.m.—Potash Meeting.

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—*Discussion on* "The Laplace Transform—a Tool for the Electrical Engineer" opened by Mr. A. C. Sim.

INSTITUTE OF INFORMATION SCIENTISTS (at the Berners Hotel, *10 Berners Street, London, W.1), at 6 p.m.—Symposium on* "Russian Technical Information". Speakers: Mr. R. Sewell, Mr. A. Post and Dr. D. J. Urquhart.

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. R. F. Jones: "Water and Ice in the Atmosphere".

Wednesday, March 11

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. D. C. Martin: "Some Achievements of the International Geophysical Year".

PALÆONTOLOGICAL ASSOCIATION (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Prof. Gerhard Regnéll (University of Lund): "The Lower *Palæozoic Echinoderm* Faunas of the British Isles and Baltо-Scandia".*

UNIVERSITY OF LONDON (in the Hatton Lecture Theatre, Queen Mary College, Mile End Road, London, E.1), at 5.30 p.m.—Prof. C. P. Whittingham: *"The Development of Experimental Botany"*.* (Inaugural Lecture).

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at 14 Belgrave Square, London, S.W.1), at 6.15 p.m.—Dr. G. C. Whiting: "Organic *Acid Metabolism* in Cider Fermentations"; Dr. Jean Scott and Mr. R. J. Rolfe: "Vitamins of the *B* Complex in Cod and the Effect on them of Dehydration".

Thursday, March 12

PHYSICAL SOCIETY, *LOW TEMPERATURE GROUP (at the Institute* of Physics, 47 Belgrave Square, London, S.W.1), at 9.30 a.m.—All-day Symposium on "Hydrogen Liquefaction and Associated Topics".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "The 'Ear' Under Water" opened by Prof. O. Lowenstein, F.R.S.

IMPERIAL COLLEGE (*in the Department of Geology, Prince Consort* Road, London, S.W.7), at 3.30 p.m.—Prof. Gerhard Regnéll (University of Lund): "The Lower Palæozoic Rocks of Sweden".*

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (*joint meeting with the* LONDON GRADUATE AND STUDENT SECTION, at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. A. P. Foster: "Coalmining and Electricity"; Mr. P. D. House: "Electric Drives in the Paper Industry"; Mr. *M. J. L. Willison*: "Standardization and Simplification of Switchgear".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—*Monsieur l'Ingénieur Général de l'Air* Noël Daum: "The Griffon and the Prospect of Combining the Turbo-Ram-Jet Engine for Propulsion of Aeroplanes at High Speeds" (Twelfth Louis Bleriot Lecture).

PLASTICS INSTITUTE (*at the Wellcome Foundation Building*, Euston Road, London, N.W.1), at 6.30 p.m.—Mr. S. P. Chambers: "International Competition in the Chemical Industry" (Tenth Annual Lecture).

ANTIQUARIAN HOROLOGICAL SOCIETY (at the Science Museum, South Kensington, London, S.W.7), at 7 p.m.—Mr. W. J. Gazeley: "The Lever Escapement".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the CHELSEA COLLEGE OF SCIENCE AND TECHNOLOGY CHEMICAL SOCIETY, at the Chelsea College of Science and Technology, Manresa Road, London, S.W.3), at 7 p.m.—Prof. E. D. Hughes, F.R.S.: "Reaction Mechanisms".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Sir Eric Rideal, F.R.S.: Irving Langmuir Memorial Lecture.

Friday, March 13

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the BRITISH NUCLEAR ENERGY CONFERENCE, at Central Hall, Westminster, London, S.W.1), at 9.30 a.m.—Lecture Symposium on the Geneva Conference.

BRITISH PSYCHOLOGICAL SOCIETY, OCCUPATIONAL PSYCHOLOGY SECTION (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 1 p.m.—Mr. A. K. Rice: "Systems of Organization".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Papers by Dr. O. J. Eggen, Dr. A. R. Sandage and Prof. F. Hoyle, F.R.S. Dr. H. E. Butler: "Possibilities of Astronomical Research with British Rockets".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. H. M. Finniston: "On Bombarding Solids with Neutrons".

Saturday, March 14

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Auditorium of the Wellcome Building, Euston Road, London, N.W.1), at 10.15 a.m. —*Symposium on "Darwin, Evolution and Modern Life"*. (*Darwin* Symposium to commemorate the Centenary of the publication of "The Origin of Species", 1859.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LABORATORY STEWARD (over 21 years of age, previous experience in a biological, medical, biochemical or chemical laboratory, and preferably experience in the preparation of biological materials, and in photography) IN THE DEPARTMENT OF BOTANY—The Registrar, *University College, Singleton Park, Swansea (March 14).*

POST-DOCTORAL FELLOW IN THE DEPARTMENT OF ORGANIC CHEMISTRY, for work on metabolites of marine micro-organisms—The Registrar, The University, Liverpool (March 14).

TUTOR OR LECTURER (woman, with special qualifications in either experimental or theoretical physics) IN PHYSICS—The Treasurer, Somerville College, Oxford (March 14).

LECTURERS (2) (one Grade II and one Grade III) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar and Secretary, The University, Bristol (March 16).

LECTURER (with special qualifications in pure mathematics) IN MATHEMATICS—The Registrar (Room 22, O.R.B.), The University, Reading (March 19).

LECTURER (with experience in the use of digital computers and qualified to give lectures in numerical analysis or the principles and details of programming) *IN THE COMPUTING LABORATORY*—The Secretary of University Court, The University, Glasgow (March 20).

PHYSICIST, Principal grade (with wide experience of hospital physics)—The Clerk to the Governors, St. Thomas's Hospital, London, *S.E.1 (March 21).*

LECTURER (preferably with experience in the design of electrical plant or control systems) IN ELECTRICAL ENGINEERING—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (March 23).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff *(March 31).*

CHAIR OF BIOLOGY in Monash University, Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (March 31).

ASSISTANT IN STATISTICS—The Secretary, *The University*, Aberdeen (April 4).

JUNIOR RESEARCH FELLOW IN THE NATURAL PRODUCTS RESEARCH UNIT, Chemistry Department, University College of the West *Indies*—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 4).

RESEARCH FELLOW (with a Ph.D. degree or equivalent research experience) IN THE CHEMISTRY DEPARTMENT, *for work on absorption* from the liquid phase by carbon absorbents, in collaboration with Dr. J. J. Kipling—The Professor of Chemistry, The University, Hull (April 6).

ASSISTANT PHYSICIST (with experience in electronics) at Auckland Hospital, New Zealand, for duties mainly concerned with a linear accelerator—The High Commissioner for New Zealand, New Zealand House, 415 Strand, London, W.C.2 (New Zealand, April 9).

LECTURER IN MATHEMATICS—The Secretary, The University, Aberdeen (April 11).

READER IN AGRICULTURAL ECONOMICS in the Newcastle Division of the University—The Registrar, *University Office, 46 North Bailey*, Durham (April 11).

LECTURERS IN EXPERIMENTAL AND THEORETICAL PHYSICS—The Secretary of University Court, The University, Glasgow (April 15).

SENIOR LECTURER IN BIOCHEMISTRY at the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 15).

ASSISTANT LECTURER or LECTURER (preferably with some experience in radiochemical techniques) IN INORGANIC CHEMISTRY—The Registrar, The University, Nottingham (April 18).

CURATOR (with an approved university degree in science or equivalent and some experience *in the taxonomy of vertebrates) OF MAMMALS* at the National Museum, Melbourne, Australia, to take charge of the mammal collections, undertake field work, conduct research upon mammals, and to assist in such other Museum matters as may be required—*The Agent-General for Victoria, Victoria House*, Melbourne Place, Strand, London, W.C.2 (April 25).

ASSISTANT PROFESSOR (with postgraduate education equivalent to the Ph.D. in plant pathology and related fields) OF PLANT PATHOLOGY in the Department of Plant Science—Head of the Department of Plant Science, University of Alberta, Edmonton, Alberta, Canada (May 1).

ASSOCIATED ELECTRICAL INDUSTRIES FELLOW IN THE DEPARTMENT OF ENGINEERING, for research in any branch of engineering—The Secretary-General of the Faculties, The University, The Old Schools, Cambridge (May 31).

ASSISTANT DIRECTOR (with a good science degree, preferably with some knowledge of genetics and/or statistics, and also a knowledge of at least two foreign languages) OF THE BUREAU OF ANIMAL BREEDING AND GENETICS, King's Buildings, West Mains Road, Edinburgh 9, Scotland—The Secretary, Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Bucks (June 14).

JOHN THOMPSON AND TUBE INVESTMENTS RESEARCH SCHOLARS (graduates of Sheffield or any other approved university), for research in mechanical engineering—The Registrar, The University, Sheffield (June 20).

HYDROLOGIST (between 23 and 45 years of age, with a degree in civil engineering and at least two years subsequent experience, or a degree in applied science with some direct experience in applied hydrology) in the Ministry of Works, Kenya, for duties which include the measuring of river flows, assessment of flood discharges, rainfall-runoff, studies and assessment of ground-water resources, their recharge and depletion—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.112/7/01/T.

LECTURER (preferably with experience of digital electronic circuit techniques) FOR TEACHING AND RESEARCH IN CONTROL ENGINEERING, to work with a group concerned with the development of statistical and digital methods in relation to all types of electrical, hydraulic and pneumatic controls—Head of the Electrical Engineering Department, Imperial College, Exhibition Road, London, S.W.7.

LECTURER (with experience in the development of electrical machines, and preferably an interest in combinations of machines and rectifiers for high power outputs) IN ELECTRICAL ENGINEERING—The Head of the Electrical Engineering Department, Imperial College, Exhibition Road, London, S.W.7.

MASTER (with a good degree, and preferably a bachelor) TO TEACH PHYSICS to Advanced and Scholarship Level—The Headmaster, Ampleforth College, York.

NATIONAL RESEARCH COUNCIL POSTDOCTORAL FELLOW IN PATHOLOGY, MYCOLOGY, PHYSIOLOGY OR CYTOLOGY; and a POSTGRADUATE FELLOW for the study of micro-organisms involved in cellulose decomposition—The Head of the Department of Botany, University of Western Ontario, London, Canada.

PHYSICIST (honours graduate), to work on radiation effects in solids—Prof. W. R. Ditchburn, Physics Research Laboratory, The University, Upper Redlands Road, Reading, Berks.

SECOND TECHNICIAN (with A.I.M.L.T. or National Certificate in Chemistry or equivalent qualifications and experience) IN THE CARDIAC LABORATORY, for biochemical investigations—The Director of Pathology, Royal South Hants Hospital, Southampton.

SENIOR LECTURER or LECTURER (graduate in pharmacy, and actively interested in research) IN PHARMACOLOGY in the Department of Pharmacy—The Registrar, Bradford Institute of Technology, Bradford 7.

SENIOR LECTURER (with a university degree or equivalent and a sound theoretical and applied knowledge of electronics) IN MEDICAL ENGINEERING (ELECTRONICS)—The Dean, Postgraduate Medical School of London, Ducane Road, London, W.12.

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS and RESEARCH FELLOWS (with a first- or second-class honours degree, an interest in high-energy plasma physics and preferably experience with microwave techniques) in a new group investigating thermonuclear experiments utilizing the injection of pre-accelerated particles into magnetic fields with mirror geometry—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. 2177/34.

UNIVERSITY DEMONSTRATOR IN BIOCHEMISTRY—The Administrator, Department of Biochemistry, The University, South Parks Road, Oxford.

ZOOLOGIST (with postgraduate training in ethology), to undertake research into the feeding behaviour of wildfowl—The Assistant Director (Research), The Wildfowl Trust, Slimbridge, Gloucestershire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Bird Migration, Vol. 1, No. 1 (December, 1958). Pp. 40. Published twice yearly in December and July. (Oxford: British Trust for Ornithology, 1958.) 2*s*. 6*d*. [11

National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1957, to 30th June, 1958. Pp. ii+28. (London: H.M. Stationery Office, 1958.) 1*s*. 6*d*. net. [11

Ealing Public Libraries. Selborne Society Library: a Catalogue of MSS. Books and Periodicals devoted to Gilbert White and Natural History. Pp. 34. (Ealing: Borough Librarian, Central Library, 1958.) [11

General Register Office. The Registrar General's Quarterly Return for England and Wales—Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates—No. 439, 3rd Quarter, 1958. Pp. 34. (London: H.M. Stationery Office, 1958.) 2*s*. net. [11

Review of Coal Tar Technology, January—June, 1958. (Vol. 10, Part 1.) Pp. ii+86. (Gomersal, Leeds: Coal Tar Research Association, 1958.) 10*s*. [11

Report of the Frederick Soddy Trust, September, 1958. Pp. 16. (Hove 3, Sussex: The Trustees, Frederick Soddy Trust, 1958.) [11

Planning, Vol. 24, No. 429 (19 September, 1958): Paying for the Railways. Pp. 277–308. (London: Political and Economic Planning, 1958.) 3*s*. 6*d*. [11

Ciba (A.R.L.), Ltd. Technical Notes, No. 192 (December, 1958): Adhesives in Sailplane Building. Pp. 8. (Duxford: Ciba (A.R.L.), Ltd., 1958.) [11

The World of Wool, 1957–58: The Annual Review of the International Wool Secretariat and the Wool Bureau Incorporated. Pp. 102. (London: International Wool Secretariat; New York: Wool Bureau Incorporated, 1958). [11

The Royal Society. British National Committee for the International Geophysical Year. Some International Geophysical Year Achievements: an Interim Statement issued at the close of the Observational Phase of the International Geophysical Year. Pp. i+16. (London: The Royal Society, 1958.) [11

Department of Scientific and Industrial Research. Estimates of Resources Devoted to Scientific and Engineering Research and Development in British Manufacturing Industry, 1955. Pp. 50. (London: H.M. Stationery Office, 1958.) 3*s*. net. [11

Report of the Nature Conservancy for the year ended 30th September, 1958. Pp. vi+119+14 plates. (London: H.M. Stationery Office, 1958.) 6*s*. 6*d*. net. [11

Colonial Research, 1957–1958: Reports of the Colonial Research Council; Committee for Colonial Agricultural, Animal Health and Forestry Research; Colonial Economic Research Committee; Colonial Fisheries Advisory Committee; Colonial Medical Research Committee; Colonial Pesticides Research Committee; Colonial Products Council; Colonial Road Research Committee; Colonial Social Science Research Council; Tsetse Fly and Trypanosomiasis Committee; Director, Anti-Locust Research Centre; and Research Matters not covered by the above Reports of the Specialist Advisory Bodies. Pp. 347. (Cmnd. 591.) (London: H.M. Stationery Office, 1958.) 14*s*. 6*d*. [11

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1958. No. 4: The Chemistry of Dinitrogen Tetroxide: The Acid-base System as the Basis of Reactivity. By Dr. Peter Gray. Pp. ii+36. 4*s*. 6*d*. net. No. 5: Recent Progress in the Chemistry of Dyes and Pigments. By Prof. W. Bradley. Pp. ii+94. 9*s*. net. (London: Royal Institute of Chemistry, 1958.) [11

Ministry of Power: Safety in Mines Research Establishment. Safety in Mines Research, 1957: Thirty-sixth Annual Report. Pp. 81+4 plates. (London: H.M. Stationery Office, 1958.) 5*s*. net. [11

Other Countries

The Nucleus, Vol. 1, No. 1 (June, 1958). An International Journal of Cytology and Allied Topics. Pp. 152. Published twice a year. Annual subscription: Rs. 46.00; 10.50 U.S. dollars. Single issues: Rs. 23.00; 5.25 U.S. dollars. (Calcutta: Dr. A. K. Sharma, Editor, Botany Department, The University, 1958.) [11

Modern Development in Plant Physiology: Report of Seminar held August 26th to 30th, 1957. Edited by P. Maheshwari. Pp. xi+170. (Delhi: Botany Department, The University, 1958.) [11

Indian National Scientific Documentation Centre. Insdoc Report, 1957–58. Pp. ii+22. (New Delhi: Indian National Scientific Documentation Centre—National Physical Laboratory of India, 1958.) [11

Tokyo Astronomical Observatory. Tokyo Astronomical Bulletin. Second Series. No. 103: Meridian Observation of Right Ascension of Equatorial Stars made with Repsold Transit Instrument—Preliminary Results. No. 13: (July–December, 1956.) By Kônosuke Tuzi. Pp. 1107–1140. No. 104: Meridian Observation of Right Ascension of Moon's Limb made with Repsold Transit Instrument. Report No. 2: (January–December, 1956.) By Kônosuke Tuzi and Kiyoshi Nagane. Pp. 1141–1151. No. 105: Polar Tube Observations during 1957. By N. Sekiguchi and J. Matsumoto. Pp. 1153–1154. No. 106: A Receiving Equipment especially designed for the Detection of Doppler Shift in received Signals. By S. Iijima, Y. Ohki and I. Oguma. Pp. 1155–1163. No. 107: Meridian Observations of the Right Ascension of Minor Planets during the year 1957. By S. Nakano, H. Yasuda and H. Hara. Pp. 1165–1166. No. 108: Meridian Observations of the Right Ascensions of the Moon and Planets during the year 1957. By S. Nakano, H. Yasuda and H. Hara. Pp. 1167–1172. (Tokyo: Tokyo Astronomical Observatory, 1958.) [11

Comptes Rendus des Travaux du Laboratoire Carlsberg. Vol. 31, No. 6: Pinocytosis of Inorganic Salts by *Amoeba Proteis* (*Chaos Diffluens*). By Cicily Chapman-Andresen. Pp. 77–92. 2 kr. 40 øre. Vol. 31, No. 7: Cryptococcus Terricolus Nov. Spec., a New Yeast Isolated from Norwegian Soils. By T. A. Pedersen. Pp. 93–103. 1 kr. 90 øre. (Copenhague: Danish Science Press, Ltd., 1958.) [11

India: Council of Scientific and Industrial Research. Central Fuel Research Institute—Report of the Director for the year 1956–57. Pp. v+71. (Jealgora, Dhanbad, Bihar: Central Fuel Research Institute, 1957.) [11

Smithsonian Institution: National Collection of Fine Arts. Henry Ward Ranger Centennial Exhibition, 1858–1958. Pp. 30. (Washington, D.C.: National Collection of Fine Arts, Smithsonian Institution, 1958.) [11

Smithsonian Institution: Bureau of American Ethnology. Bulletin 168: The Native Brotherhoods: Modern Intertribal Organizations on the Northwest Coasts. By Philip Drucker. Pp. iv+194. (Washington, D.C.: Government Printing Office, 1958.) 1 dollar. [11

Smithsonian Miscellaneous Collections. Vol. 135, No. 1: The Customs and Religion of the Ch'iang. By David Crockett Graham. Pp. vii+114+16 plates. (Publication 4300.) (Washington, D.C.: Smithsonian Institution, 1958.) [11

Annals of the New York Academy of Sciences. Vol. 76, Article 3: Screening Procedures for Experimental Cancer Chemotherapy. By Chester Stock and 77 other authors. Pp. 409–970. (New York: New York Academy of Sciences, 1958.) 5 dollars. [11

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 39 (November, 1958): Widows Increasing in Number. Hazards in Plural Birth. Proportion of Women in Population Increasing. Accident Death Toll in Canada. Pp. 12. (New York: Metropolitan Life Insurance Company, 1958.) [11

The Gardens Bulletin, Singapore. Vol. 16 (1st August, 1958): Bamboos of Malaya. By R. E. Holttum. Eugeninae of Malaya. By G. A. Prowse. A Revision of the Malayan Myristicaceae. By J. Sinclair. Pp. 472+14 plates. (Singapore: Botanic Gardens, 1958.) 25 Malayan dollars. [11

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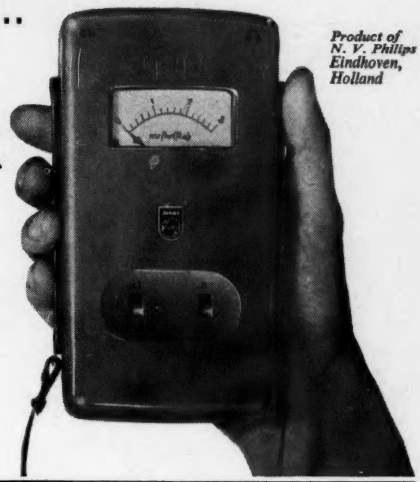

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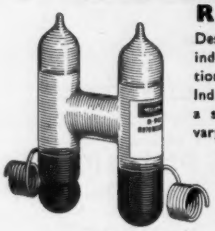

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